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Promoting self-management for vulnerable people with chronic conditions using electronic and telehealth tools: A systematic review and realist synthesis

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Promoting self-management for vulnerable people with chronic conditions using electronic and telehealth tools: A systematic review and realist synthesis

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Abstract

Objectives:

The objective of this review was to assess via systematic processes and realist synthesis the benefit of using electronic and telehealth tools for vulnerable patients with chronic disease, and to explore the mechanisms by which these tools impact patient self-efficacy and self-management.

Setting:

Studies of any design conducted in community based primary care.

Participants:

Adults with one or more diagnosed chronic health conditions and vulnerability due to demographic, geographic, economic and/or cultural characteristics that impede or compromise their access to health care.

Interventions:

Electronic, mobile or telehealth interventions.

Results:

Fifteen eligible trials were identified targeting a range of chronic conditions and vulnerabilities. The data provided limited insight into the mechanisms underpinning these interventions which sought to persuade vulnerable patients into believing they could self-manage their conditions through goal setting and providing rewards for achievement. Patients were relatively passive in the interaction, and the level of patient response attributed to their intrinsic level of motivation. Health literacy, which may be confounded with motivation, was only measured in one study and eHealth literacy was not assessed.

Conclusions:

Research incorporating eHealth and telehealth tools with vulnerable groups is not comprehensive. Apart from intrinsic motivation, health literacy may be a factor influencing the reaction of vulnerable groups to technology. Social persuasion, goal setting and motivational counselling were the dominant components within interventions which sought to achieve better self-management. Efforts to engage patients by health care providers were lower than expected. Use of social networks or other eHealth mechanisms to link patients and provide opportunities for vicarious experience were not identified but could be further explored in relation to vulnerable groups. Future research should attempt to assess health and eHealth literacy, and to differentiate the specific needs for vulnerable groups when implementing health technologies.

Trial Registration: This systematic review is not registered.

Strengths and limitations of this study:

- The use of systematic processes to identify both quantitative and qualitative data
- The use of Rameses and PRISMA reporting standards
- Incorporation of theory and mapping against a theoretical framework and realist matrix
- Limited descriptions of context provided in the published studies

Keywords: family medicine, primary care, telehealth, e-health, chronic disease, vulnerable population

BACKGROUND

Chronic conditions result in significant personal and social burden [1]. Electronic and telehealth tools are increasingly commonplace, can be provided at relatively low cost [2], and incorporate personally relevant health information [3]. For those vulnerable and underserved community members with chronic or long term conditions, electronic applications may enhance the reach of health services and the provision of tailored need based services [4, 5]. The growing impetus to use these technologies is largely underpinned by their potential to intervene in the course of health care, and influence the way people deal with their health issues[6]. There is also an expectation that health technologies will engage consumers in appropriate self-care and self-management [7], which within the health delivery sphere, shifts the responsibility solely from the clinician, to one which is jointly shared by the health provider and patient.

Electronic health (eHealth) tools incorporate many opportunities for patients to increase their engagement through focused disease specific learning, options to receive regular feedback and frequent reinforcement (e.g. peripheral monitoring devices) [8]. In-built support functions which assess progress, provide goal setting and problem solving, aim to increase the patient’s skill and confidence in managing their health problems [9]. Supplementary motivational interviewing and cognitive behavioural components can also be provided via the internet, mobile device or telephone[10] .

The claims made by health-related apps, websites and other electronic tools remain largely unverified, and more specifically, little is known about their value for vulnerable and marginalised groups. Within the Innovative Models Promoting Access-to-Care Transformation (IMPACT) program, we aimed to assess, via a systematic review and realist synthesis, the perceived benefit of using electronic tools to enhance the engagement of vulnerable patients with chronic disease. We used

realist methodology as a way of unpacking the complexity surrounding eHealth interventions [11]. This methodology explains the interplay between context, mechanisms and outcomes [12] where mechanisms are not activities within the intervention, but the responses by people that are triggered by changes in context [13]. In this review, we specifically sought to explore mechanisms related to patient self-efficacy and self-management. The impact of these tools on access to health care more broadly, is the topic of a future manuscript.

Defining the research question

Our research question was formulated through a collaborative process with the South-Western Sydney Local Innovative Partnership (LIP) comprising policy makers, healthcare providers and field experts involved in service provision to key vulnerable communities. Two deliberative forums identified key priorities around service access, and it was through this process that the question around electronic health solutions emerged. A Technical Advisory Group (TAG), made up of six content experts with considerable experience with the implementation of e/m/telehealth tools in primary care, reviewed the scope of the review, directed the review team to salient reports and literature and critiqued the draft report prior to its presentation back to the LIP.

There are many and varied definitions of eHealth, mhealth and telehealth used across the health sector [1]. The following were used for this review: -

- ❖ *Electronic health (**eHealth**), is the general transfer of health resources and health care by electronic means through the Internet and telecommunications [14].*
- ❖ *Mobile health (**mHealth**), is the delivery of healthcare services via mobile/wireless communication devices such as smartphones and tablets*
- ❖ ***Telehealth** describes the use of telecommunication techniques (voice, data, images) for providing telemedicine (remote clinical service delivery), medical education, and health education over a distance [15]. Telehealth encompasses long-distance clinical health care, patient and professional health-related education, public health and health administration.*

METHODS

Our processes were based on standard systematic review methodology [16]. Realist synthesis similarly follows the stages of a traditional systematic review except the appraisal of evidence is theoretically driven and intent on explaining why the intervention works or doesn't work [17]. Reporting has been guided by the Rameses publication standards for reporting realist synthesis [18] and the PRISMA statement [19].

We searched Medline, All Evidence Based Medicine (All EBM) CINAHL, EMBASE, and PsychINFO covering the period 1/1/2009 to 6/7/2015. Our basic search strategy (Table 1) was modified for each database. We supplemented this with a search of international websites and two specialist grey literature databases (OpenGrey and The Grey Literature Report). We asked our TAG members to direct us to relevant literature and supplemented these processes with iterative search methods including searching for other publications mentioned by authors, reference lists and contacting authors for missing information.

The criteria for study selection are described in Table 2. We did not exclude studies based on design as we wanted to collect a richer understanding of the interventions but excluded letters or opinion pieces. Included studies required a description of the e/m/telehealth intervention and/or its components. Intervention populations included adults with one or more diagnosed chronic health conditions and vulnerability due to demographic, geographic, economic and/or cultural characteristics that impede or compromise their access to community based primary health care. We selected only studies originating in Organisation for Economic Cooperation and Development (OECD) countries.

Interventions which did not have coaching/skill improvement components and ongoing skill development were excluded, as well as those programs used solely for simple self-monitoring of symptoms. Inpatient hospital based services were excluded, as were those not presenting evaluative data, and those involving primarily children or adolescent populations.

Study selection process

Each title and abstract was reviewed by two authors (SP and AP) to determine eligibility. For citations requiring full text review, SP and AP reviewed 50% of papers each with final inclusion determined through joint discussion and review. The website and grey literature search was undertaken by DM; AP reviewed the results in more depth to determine relevance and inclusion.

Data collection and study variables

Data was collected using a five page data collection form within an Access database incorporating the REAIM framework [20], the TIDieR Framework [21], the PROGRESS framework [22] and several pre-defined variables including study type, country of origin, the procedures, activities, and/or processes used in the interventions, supportive activities, recipients and the personnel involved in delivery of the intervention and reported study outcomes.

Quality appraisal

Within realist synthesis there is no accepted process for assessing quality. Pawson [12] argues that quality should not determine inclusion, but a realist synthesis should provide a 'quality filter' [23] which assesses the contribution of data to *rigour* (whether the method used to generate the data is credible and trustworthy), *and relevance* (whether it contributes to theory building and/or testing) [18]. We used a method described by O'Campo [24] due to recognition that the most useful study information may not be within the reports of studies with the highest quality.

Studies were classified against the criteria (Table 3) by one author (SP) and confirmed by a second author (AP). Rigour was assessed as ‘high’, ‘moderate’ or ‘weak’ and plotted on a continuum from 0-7. One point was allocated for each positive response and studies graded as high (7 points), moderate (4-6 points) and low (0-3 points). Relevance was assessed based on ‘thick’ or ‘thin’ descriptions of the intervention components and their mechanisms. One point was allocated for each ‘yes’ answer and studies considered thick (3-4 points) or thin (0-2 points).

Realist Synthesis

At the core of realist synthesis is to make explicit the underlying assumptions as to how an intervention is supposed to work, and to then map the evidence in a systematic way to test and refine this theory [25]. We developed a linear logic model to explain the engagement of primary care providers and patients in the use of mobile, telehealth and eHealth tools (Figure 1). We explored known theories associated with patient self-efficacy and self-management, and extracted data against a realist matrix using those included studies that had been assessed as providing a ‘thick’ description of the intervention. The matrix comprised documented results from each study plus relevant author discussion which attempted to place their results into context. Realist matrices are a complementary approach to outcome chains and other programme logic models. A realist matrix focuses on the causal mechanisms at work in a programme or project [26] and it helps to map the factors from a programme that may be contributing to outcomes by reflecting on:

- Agency: Whose actions exactly are causing the change to occur?
- Context: What are the external variables or ‘moderators’ that affect outcomes? including the impact of the social and political situation, broad social or geographic features, and different population profiles
- Resources: What resources have been provided or are available?
- Mechanism: How are the resources and the thing/person being changed interact?

- Outcome: What is the anticipated change relating to self-efficacy and self-management under the specified conditions?

RESULTS

From 816 records initially identified, 210 duplicates were removed and a further 467 excluded after title and abstract screening. Eligibility was frequently difficult to assess from the title and abstract, so 139 citations underwent a brief full text review, resulting in 109 exclusions. We identified five additional related publications that were also eligible. Thirty-five citations underwent data extraction. Thirteen were excluded on the basis that they described simple tele-monitoring only, did not provide data related to the intervention, were of an incorrect publication type, or contained a population not meeting our definition of vulnerable. Twenty two citations relating to fifteen separate studies were ultimately included (Figure 2) [19].

Randomised controlled trials (RCTs) and cluster RCTs were the predominant study types. Two studies compared alternative interventions [27, 28].

Appraisal of studies for rigour and relevance

Generally, studies were of moderate to high rigour (13/15 studies), and most (9/15 studies) provided additional contextual information (Tables 4 and 5).

Assessment of self-efficacy and self-management from study reported outcomes

Studies predominantly assessed a range of clinical and functional outcomes. Several proxy outcomes (that might reasonably be used to make assumptions about the effect on self-efficacy and self-management) were included such as feasibility, satisfaction and acceptability (Tables 4 and 5).

Several studies reported positive changes in health behaviour (improved lifestyle indicators), increased compliance and adherence to lifestyle goals, and satisfaction with services.

From our logic model, we anticipated that access to reliable electronic tools, supported through a health care environment, would enhance patients’ ability to obtain, process, and understand relevant health information (health literacy), thereby improving efficacy and their capacity to self-manage their chronic condition. The information provided by the studies was inconclusive as to whether this was achieved. Only one study [28] actively assessed health literacy and tailored their intervention accordingly. No studies assessed e-health literacy.

Overall satisfaction with the use of eHealth and telehealth tools by patients was generally positive. Satisfaction was directly related to the participant’s perceived relevance of the tools and the level of positivity in the relationship with the intervention provider. In two studies [29, 30] patients expressed high levels of satisfaction from their interaction with nurses which promoted better understanding of their condition. Other studies showed high levels of willingness among patients to use tele-monitoring equipment (95%) and recommend it to others (90%) or pay for telehealth services [31].

Theoretical basis for the interventions

For most studies, the choice of intervention had no documented theoretical basis. Interventions developed from either a supporting rationale or belief in the benefit of the intervention. These broad principles or frameworks surrounded equitable access, evidence based medicine, quality improvement, and the improvement of health literacy. Only two associated studies specifically commented on the theoretical basis underpinning their intervention [32, 33]. This incorporated motivational interviewing “grounded in social cognitive theory constructs of self-efficacy, social

support and outcome expectancies, which emphasized the building of participant skills in behaviour change strategies”.

Theory Mapping

Through theory we wanted to explore how eHealth and telehealth interventions might influence an individual's response (through learning and behaviour change) towards self-efficacy and self-management. Self-efficacy and self-management are interwoven concepts. Self-efficacy is the sense of patient confidence in their ability to exert control over their own motivation, behaviour, and social environment, and self-management is active participation by the patient in their own healthcare. The theory of self-efficacy stems from social cognitive theory and describes the interaction between behavioural, personal, and environmental factors in relation to health and chronic disease [34]. This theory proposes that a patient's confidence in their ability to perform specific health behaviours will subsequently influence which behaviours they will engage in [34-36]. A sense of self-efficacy is an important driver of sustained behaviour change [8]. A patient's perceived level of self-efficacy in turn will have a mediating influence on self-management which is a more grounded and process driven activity. It is the adoption and maintenance of changes in health behaviour [37] which in turn can lead to longer term changes in health outcomes. Accordingly, “self-care behaviour is the end result of cognitive processes that people employ when acquiring knowledge [34].”

Four components of self-efficacy theory influences an individual's actions; performance accomplishments, vicarious experience, social persuasion and physiological and emotional states[38]. From our matrix (Table 6), the study interventions used a range of resources designed to increase the skill mastery of individuals such as assessment and feedback [32], goal setting [27, 28, 32, 33], workbooks [28, 32, 33], websites and training to use tools [39, 40]. Additional resource materials which encouraged participation, or guided participants through the intervention process

were frequently provided and translated [31, 39]. Mastery with the ‘technology divide’ was in-built in some interventions but not all. Self-efficacy can be enhanced by observing people around us and interacting with those who have had similar experiences (i.e via vicarious experience). When we observe others succeed through sustained effort (e.g lose weight), this raises our beliefs that we too possess the capabilities to master the activities needed for success in that area. Not only might beliefs change regarding capability, but these types of vicarious experiences serve to transfer information and skills, create opportunities to learn new behaviours and potentially increase motivation. Within the included studies vicarious experience was not targeted except for one low quality study which employed a peer to previously homeless veterans with chronic disease to enhance the use of telehealth for self-monitoring [29]. The largest concentration of effort within the interventions related to social persuasion or those activities where people are led, through suggestion, into believing that they can achieve a task. This was provided through motivational interviewing to manage expectations [33], behavioural activation approaches [27, 41] and counselling [28, 41]. Activities were purposefully designed to provide encouragement (e.g. goal setting), were easily attainable and focused on achievements and rewards [33]. Physical and/or psychological morbidities were common among the populations, and due to the negative judgements and emotional reactions that go hand in hand with these conditions, significant effort within the interventions targeted cognitive behavioural pursuits, reframing, and increasing positive experiences and pleasurable activities.

Contextual factors identified

There was extensive contextual heterogeneity among the interventions (Table 7). Most were conducted in the United States of America (USA) and hence the services in which they were delivered were frequently part of government funded health plans (Medicare and Medicaid) providing services for the elderly, disabled and poor. Patients were enrolled from a range of primary care settings (general practice; community health; supported veteran programs; outpatient

programs; community home care and US federally funded health centres/Medicaid); the interventions were overwhelmingly home based and unsupervised. Interventions targeted populations with a range of chronic conditions and vulnerabilities (older age >55yrs, low socioeconomic status (SES), difficulties with accommodation (previously homeless persons in supported accommodation, and rural communities with a mixture of lower socio-economic and underserved populations). Studies largely were artificial environments where intervention providers were put in place specifically for the period of the research. In some studies, it was not possible to know the degree to which routine clinical/service staff were incorporated into the delivery of the intervention. Some services 'tagged' interventions onto existing service structure and in many cases extra services and staff were temporarily employed to conduct interventions. Only one study [31] had a system of 'organisational readiness' where significant time had been spent developing a mental health service that could provide depression treatment to patients.

The interaction with patients came from a range of primary care providers (nurses, counsellors, diabetes educators, pharmacists etc.) with one only utilising a lay/peer provider. Although providers were predominantly nurses operating in a variety of roles there was no evidence that this was associated with a different outcome to that of other providers. Surprisingly, general practitioners (GPs) (or their equivalents) did not deliver any of the interventions so no conclusions could be drawn about their role in delivering or negotiating these interventions with patients. Interventions were additional to the care of the GP or compared to the usual care provided by the GP. In some cases, enhanced usual care was utilised and in others the GP was peripheral to the main intervention activity in that they prescribed medications or reviewed guidelines with the patient or participated in dialogue with the intervention staff over management.

Nine studies could be sub-categorised as providing a purely telehealth intervention, and six studies combined eHealth elements with telehealth (Table 4 and Table 5). All but one study provided a

telephone based service. Interventions were all multi-component and designed to address one or more health disparity for underserved populations. In addition to telephone or video support, interventions provided a varied range of additional components including, but not limited to: in home devices with prompts (4 studies); self-management education (12 studies); brief counselling (7 studies); ancillary patient devices (e.g. pedometers, BP cuffs, blood glucose monitors) (6 studies); paper or electronic patient information resources (6 studies); medication management (5 studies); stepped care (2 studies) and bilingual providers (4 studies).

We found no studies which used mobile health for vulnerable populations either singularly or in conjunction with other eHealth interventions.

Mechanisms

Within realist synthesis, a mechanism is a response that is triggered by changes in context [13]. Given the contextual heterogeneity it was not possible to clearly identify these reactions.

The level of an individual’s ‘motivation’ or ‘activation’ was one possible mechanism prompting patients to respond either positively or negatively to the situations in which the intervention was employed [33, 41]. Feelings of ‘being supported’ [31, 41]; having ‘a sense of purpose’ [41] and experiencing ‘a sense of achievement’ [41] are interwoven reactions that may also contribute to overriding motivation. It was difficult to know how the level of rapport/interaction between patient and provider contributed in these instances, although it was highlighted as an important contributor in some studies [27, 40, 41], and is a well-recognised enabling factor in self-efficacy and self-management programs generally.

One study suggested that patients with limited motivation should be excluded from these types of interventions [33], instead of providing efforts to ‘kick start’ motivation. Intuitively being motivated

to seek assistance is a major driver in this process, but it is also a complex reaction in this type of population. Low levels of health literacy can affect the degree to which a person is motivated to act and equally low motivation can be construed as low health literacy. These intrinsic aspects were not assessed with patients prior to the provision of the interventions but rather, seen as a factor in their failure. Also, most studies in this review made assumptions about the level of health literacy among participants (i.e that it was low), based on characteristics (e.g. low socioeconomic status or cultural background) although this was infrequently formally assessed. Only one study measured and/or categorised participants by their health literacy level [28]. It is therefore not possible to comment how the levels of health literacy (or e-health literacy) influenced participant response.

Other contributing factors

Despite a strong underlying certitude around the value of the interventions to produce improvements in patient self-efficacy and self-management, we identified from the studies a tendency for the intervention provider to be the dominant player within the interaction, and the patient a more passive participant. Patients were rarely required to act or respond independently outside of the contact made with them by the provider. For example, if the intervention was built around regular telephone contact to the patient, the participant would not be required to perform any self-rated or examinable activity, either during or after the call. In addition, negotiation involving the patient was also not incorporated into routine monitoring tools, where protocols frequently determined the messaging or educational content fed back to the patient. The interventions involved little opportunity for patients to explore the vicarious experience of others, or work with those with shared lived experience which are features underpinning self-efficacy.

Studies reported several barriers to the use and uptake of tools by patients. These included a general unease or mistrust with the use of technology [39, 40] and a preference for face to face contact on the part of patients [31]; and pressures of added workloads [41], reduced time and

inadequate skills on the part of clinicians to take on additional roles [32]. We found less age related barriers in this review with elderly populations equally satisfied if interventions were well designed, user friendly, and supported. We anticipated that the most significant enabling factor would be patient training. However overall, we found the information relating to patient education and training to be sparse.

DISCUSSION

We identified a small number of telehealth and eHealth interventions that had been specifically tested with vulnerable populations but no interventions using mobile technologies. The included studies provided limited insight into the relationships between context, mechanisms and self-management outcomes related to electronic and telehealth interventions. We identified a wide range of contextual factors and variation in the outcomes reported. Predominantly the interventions sought to persuade patients into believing they could self-manage their conditions by encouraging goal setting and providing rewards for achievement. There was no sharing of experiences among participants and no in-built opportunities for this within interventions. Increasingly research in this area indicates that providing avenues for social influence through on-line and interactive networks via eHealth can impact health behaviours [42]. Within this review patients were viewed by providers as relatively passive, and the level of patient response directly aligned to their intrinsic level of motivation. Health literacy, which can often be confounded with motivation, was only measured in one study and eHealth literacy was not assessed.

The provision of electronic tools to patients with chronic disease assumes that they directly impact on a patient’s level of health literacy, and subsequently their capacity to self-manage their health conditions. The studies in this review however reported poorly on self-management and literacy outcomes and we therefore don’t know if the intensive educational or behavioural activation

components of the interventions identified were ultimately effective. Using tools to assess baseline health and eHealth literacy levels may therefore be beneficial particularly if the intervention is tailored to individual needs and abilities. It would be highly valuable if future research could unpack this further since the mechanisms around this were largely unclear from this review, and the inter-relationship between these factors is highly complex. This is particularly true for those patients with competing physical and/or psychological morbidities.

These findings have implications for future implementation of eHealth and telehealth based interventions. Other studies have reported variable uptake and poor maintenance, leading some to suggest that these interventions are only offered to those with high levels of intrinsic motivation [33]. This review would suggest that more attention be given to identifying the specific needs of vulnerable groups and highly tailoring interventions to these to be more effective, since we found reasonable levels of satisfaction and acceptance when patients perceived the intervention to be relevant to their needs, and adequately supported. We found no evidence of negative patient consequences from any of the interventions. Acceptance of health technology may also be related to a participants' understanding of their condition and their overall interest in their own health or health literacy. There was also some evidence to suggest that the level of acceptance was not consistent for all participants who fall into the 'vulnerable' category. It is possible that this relates to the many and varied contextual factors providing influence at a given time, such as competing health, social and cultural issues, although this could not be elaborated from this review.

We limited our search to the years 2009-2015 for reasons of pragmatism however we understand that this is an emerging field with new data being published regularly, hence this review may not encompass the totality of evidence. Generally, there was a lack of studies involving vulnerable participants, particularly in groups speaking English as a second language. Most studies were conducted in the US where social disadvantage was the major focus.

This review was conducted to address specific issues of need within the South West Sydney LIP and will inform future programs for vulnerable groups. The strength of this review is the use of systematic processes to identify both quantitative and qualitative data and the use of Rameses publication standards as a basis for our reporting [18]. We also incorporated a realist matrix and mapped our results according to self-efficacy theory to both determine and understand the mechanisms by which eHealth and telehealth influences self-efficacy and self-management for vulnerable patients with chronic disease. This withstanding, we found the realist component of this review challenging. The major drawback for this approach in our experience was the limited descriptions of context and mechanisms provided generally within published studies. The limited quantity of usable data inhibited our ability to effectively identify why these types of interventions worked (or didn't work) differently across the varying primary health care contexts. Others have commented that the iterative and flexible methods required for realist reviews are at odds with the inflexible, structured processes inherent when conducting systematic reviews generally [13]. Berg [43] in a review of published realist reviews found that limitations frequently cited include the scarcity of detail around the mechanisms by which an intervention was expected to work, and the diversity of contexts within studies which hamper generalisability. Developing the necessary skill set, and sourcing appropriate guidance to perform a realist synthesis was also a major challenge. We chose to use a realist matrix and narrative summary because it provided a more structured process that we could follow. Others have also highlighted difficulties with incorporating realist methods, arguing that few studies incorporate it successfully while maintaining transparent and systematic methods because 'best practice' is under developed [44] and there is currently little uniformity in practice [43].

CONCLUSIONS

Although electronic, mobile and telehealth interventions have been widely assessed in several disease specific groups covering the general population; specific research with vulnerable groups is

much less comprehensive. We found only fifteen separate studies that had provided these interventions to vulnerable patients. The level of reported success was variable, but the reasons for this variation were not clear. Apart from intrinsic motivation, health literacy may be a factor influencing the reaction of vulnerable groups to technology. Goal setting, behavioural activation and motivational counselling were able to be successfully delivered by telephone or other e-health modalities but efforts to engage patients by health care providers were lower than expected.

Social persuasion and goal setting were the dominant components by which studies sought to achieve better self-management. Other theoretical aspects that underpin self-efficacy such as vicarious learning and interaction with similar people were not used but may warrant further research.

We would also encourage in future research some assessment of both health and eHealth literacy if including vulnerable populations, and further work to differentiate specific requirements for these groups that might differ to the general population when implementing health technologies.

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AUTHORSHIP STATEMENT

SP contributed to the project methodology and design of the review; coordinated the review, designed and conducted the search, adjudicated and appraised studies, extracted and analysed data and drafted the manuscript. AP coordinated the deliberate forums and question development, designed and conducted the search, adjudicated and appraised studies, extracted and analysed data and reviewed the manuscript. LT and HS contributed to the search and the design of the analysis, extracted and analysed data and reviewed the draft manuscript. DM contributed to the question development through the LIP, conducted the grey search and data extraction and reviewed the manuscript. MH designed the IMPACT program of work, analysed and interpreted data and reviewed the manuscript. All authors have signed off on the final content of this manuscript

AUTHOR DISCLOSURE STATEMENT

The named authors declare that no competing or financial interests exist in relation to this work.

DATA SHARING STATEMENT

No additional data are available. Data extracted from included studies relevant to the discussion in this manuscript has been provided in Table 4 and Table 5.

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REFERENCES

1. Gee PM, Greenwood DA, Paterniti DA, Ward D, Miller LMS: The eHealth Enhanced Chronic Care Model: A Theory Derivation Approach. *Journal of Medical Internet Research* 2015, 17(4):e86.

2. Voncken-Brewster V, Tange H, Moser A, Nagykaldi Z, de Vries H, T. vdW: Integrating a tailored e-health self-management application for chronic obstructive pulmonary disease patients into primary care: a pilot study. *BMC Family Practice* 2014, 415(4).

3. Gomez Quiñonez S, Walthouwer MJL, Schulz DN, de Vries H: mHealth or eHealth? Efficacy, Use, and Appreciation of a Web-Based Computer-Tailored Physical Activity Intervention for Dutch Adults: A Randomized Controlled Trial. . *Journal of Medical Internet Research* 2016, 18(11):e278.

4. Georgeff M: Digital technologies and chronic disease management. *Australian Family Physician* 2014, 43(12):842-846.

5. Royal Australian College of General Practitioners (RACGP): The RACGP Curriculum for Australian General Practice 2011. Melbourne: RACGP; 2011.

6. Mackert M, Champlin S, Holton A, Munoz I, Damasio M: eHealth and Health Literacy: A Research Methodology Review. *Journal of Computer-Mediated Communication* 2014, 19:516-528.

7. Kim H, Xie B: Health literacy in the eHealth era: A systematic review of the literature. *Patient Education and Counselling* 2016.

8. Ciere Y, Cartwright M, Newman SP: A systematic review of the mediating role of knowledge, self-efficacy and self-care behaviour in telehealth patients with heart failure. *Journal of Telemedicine and Telecare* 2012, 18(7):384-391.

9. Adams K, Corrigan JM: Priority Areas for National Action: Transforming Health Care Quality. Washington (DC): National Academies Press (US): Institute of Medicine (US) Committee on Identifying Priority Areas for Quality Improvement 2003.

10. Rollnick S, Miller WR, Butler CC: Motivational interviewing in health care: Helping patients change behavior. New York: The Guilford Press; 2008.

11. Maggie Bartlett, Ruth Basten, Robert K McKinley: Green shoots of recovery: a realist evaluation of a team to support change in general practice. *BMJ Open* 2016, 7: e014165.

12. Pawson R, Greenhalgh T, Harvey G, Walshe K: Realist review – a new method of systematic review designed for complex policy interventions. *Journal of Health Services Research & Policy* 2005, 10(Suppl 1):21-34.

13. Saul JE, Willis CD, Bitz J, Best A: A time-responsive tool for informing policy making: rapid realist review. *Implementation Science* 2013, 8(103).

14. Glossary of globalization, trade and health terms [<http://www.who.int/trade/glossary/en/>]

15. Telehealth [<http://health.gov.au/internet/main/publishing.nsf/Content/e-health-telehealth>]
16. Centre for Reviews and Dissemination: Systematic Reviews. CRD's guidance for undertaking reviews in health care. York, UK: CRD, University of York; 2009.
17. Jo Rycroft-Malone, Brendan McCormack, Alison M Hutchinson *et al*: Realist synthesis : illustrating the method for implementation research. *Implementation science* 2012, 7(33):1-22.
18. Wong G, Greenhalgh T, Westhorp G, Buckingham J, Pawson R: RAMESES publication standards: realist syntheses. *BMC Medicine* 2013, 11(1):1-14.
19. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group: Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 2009, 6(7):e1000097.
20. Glasgow RE, McKay HG, Piette JD, Reynolds KD: The RE-AIM framework for evaluating interventions: what can it tell us about approaches to chronic illness management? *Patient Education and Counseling* 2001, 44(2):119-127.
21. Tammy C Hoffmann, Paul P Glasziou, Isabelle Boutron *et al*: Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014, 7(348):g1687).
22. Neill J, Tabish H, Welch V, Petticrew M, Pottie K, Clarke M: Applying an equity lens to interventions: Using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. *Journal of Clinical Epidemiology* 2014, 67:56-64.
23. Kastner M, Estey E, Perrier L, Graham ID, Grimshaw J, Straus SE, Zwarenstein M, Bhattacharyya O: Understanding the relationship between the perceived characteristics of clinical practice guidelines and their uptake: protocol for a realist review. *Implementation Science* 2011, 6(1):1-9.
24. O'Campo P, Kirst M, Tsamis C, Chambers C, Ahmad F: Implementing successful intimate partner violence screening programs in health care settings: Evidence generated from a realist-informed systematic review. *Social Science & Medicine* 2011, 72(6):855-866.
25. Pawson R, Greenhalgh T, Harvey G, Walshe K: Realist synthesis: an introduction. ESRC Research Methods Programme Working Paper Series August 2004. University of Manchester; 2004.
26. Realist matrix [http://betterevaluation.org/evaluation-options/realist_matrix]
27. Fortney JC, Pyne JM, Mouden SB *et al*: Practice-based versus telemedicine-based collaborative care for depression in rural federally qualified health centers: a pragmatic randomized comparative effectiveness trial. *American Journal of Psychiatry* 2013, 170(4):414-425.
28. Wolf MS, Seligman H, Davis TC, Fleming DA, Curtis LM, Pandit AU, Parker RM, Schillinger D, Dewalt DA: Clinic-based versus outsourced implementation of a diabetes health literacy intervention. *Journal of General Internal Medicine* 2014, 29(1):59-67.

29. Gabrielian S, Yuan A, Andersen RM, McGuire J, Rubenstein L, Sapir N, Gelberg L: Chronic disease management for recently homeless veterans: a clinical practice improvement program to apply home telehealth technology to a vulnerable population. *Medical Care* 2013, 51(3 Suppl 1):S44-51.

30. Gellis ZD, Kenaley BL, Have TT: Integrated telehealth care for chronic illness and depression in geriatric home care patients: The integrated telehealth education and activation of mood (I-TEAM) study. *Journal of the American Geriatrics Society* 2014, 62(5):889-895.

31. Chong J, Moreno F: Feasibility and acceptability of clinic-based telepsychiatry for low-income Hispanic primary care patients. *Telemedicine journal and e-health : the official journal of the American Telemedicine Association* 2012, 18(4):297-304.

32. Eakin E, Reeves M, Lawler S, Graves N, Oldenburg B, Del Mar C, Wilke K, Winkler E, Barnett A: Telephone counseling for physical activity and diet in primary care patients. *American Journal of Preventive Medicine* 2009, 36(2):142-149.

33. Eakin E., Winkler E, Dunstan D, Healy G, Owen N, Marshall A, Graves N, Reeves M: Living well with diabetes: 24 month outcomes from a randomised trial of telephone delivered weight loss and physical activity intervention to improve glycemic control. *Diabetes Care* 2014, 37:2177-2185.

34. Bandura A: Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review* 1977, 84(2):191-215.

35. Bandura A: Self-efficacy: The exercise of control. New York: W.H. Freeman; 1997.

36. Lorig KR, Holman HR: Self-management education: History, definition, outcomes, and mechanisms. *Annals of Behavioral Medicine*, 26(1):1-7.

37. Marks R, Allegrante JP: A Review and Synthesis of Research Evidence for Self-Efficacy-Enhancing Interventions for Reducing Chronic Disability: Implications for Health Education Practice (Part II). *Health Promotion Practice* 2005, 6(2):148-156.

38. Hoffman A: Enhancing Self-Efficacy for Optimized Patient Outcomes through the Theory of Symptom Self-Management. *Cancer Nursing* 2013, 36 (1):E16-E26.

39. Shea S, Weinstock R, Teresi J *et al*: A randomised trial comparing telemedicine case management with usual care in older, ethnically diverse, medically underserved patients with diabetes mellitus: five year results of the IDEATel study. *Journal of American Information Association* 2009, 16:446-456.

40. Sheeran T, Rabinowitz T, Lotterman J, Reilly CF, Brown S, Donehower P, Ellsworth E, Amour JL, Bruce ML: Feasibility and impact of telemonitor-based depression care management for geriatric homecare patients. *Telemedicine journal and e-health : the official journal of the American Telemedicine Association* 2011, 17(8):620-626.

41. Sheldon C, Waxmonsky JA, Meir R, Morris C, Finkelstein L, Sosa M, Brody D: Telephone assessment, support, and counseling for depression in primary care medical clinics. *Cognitive and Behavioral Practice* 2014, 21(3):282-295.

42. Liliana Laranjo, Amae" I Arguel, Ana L Neves, Aideen M Gallagher, Ruth Kaplan, Nathan Mortimer, Guilherme A Mendes, Annie Y S Lau: The influence of social networking sites on

health behavior change: a systematic review and meta-analysis. *Journal of the American Medical Information Association* 2015, 22:243–256.

43. Berg R, Nanavati J: Realist Review: Current Practice and Future Prospects. *Journal of Research Practice* 2016, 12(Article R1).
44. Walker D, Bergh G, Page E, Duvendack M: Adapting systematic reviews for social research in international development: a case study on child protection *Shaping Policy for Development*. The Overseas Development Institute (UK independent think tank on international development and humanitarian issues); 2013.

For peer review only

Table 1. Search strategy conducted 6/7/2015 and modified for each database

Search terms	
1	telemedicine/
2	ehealth.mp.
3	E health.mp.
4	electronic health.mp.
5	internet health.mp.
6	mhealth.mp.
7	m health.mp.
8	mobile health.mp.
9	mobile health devices.mp.
10	social media/
11	telephone/
12	telehealth.mp.
13	tele health.mp.
14	telehomecare.mp.
15	text messaging/
16	exp therapy, computer-assisted/
17	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18	exp medical records systems, computerized/
19	17 not 18
20	primary health care/
21	exp family practice/
22	exp general practice/
23	exp physicians, family/
24	practice nurse.mp.
25	nutritionists/ or physical therapists/
26	pharmacists/
27	aboriginal health worker.mp.
28	audiologist.mp.
29	diabetes educator.mp.
30	exercise physiologist.mp.
31	occupational therapist.mp.
32	osteopathic physicians/
33	podiatrist.mp.
34	home care services/
35	20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34
36	chronic disease/
37	long term illness.mp.
38	long term condition.mp.
39	multimorbidity.mp.
40	multi morbidity.mp.
41	myocardial ischemia/
42	stroke/
43	lung neoplasms/
44	colorectal neoplasms/
45	exp depression/
46	diabetes mellitus, type 2/
47	arthritis/
48	pulmonary disease, chronic obstructive/
49	osteoporosis/
50	asthma/
51	renal insufficiency, chronic/
52	dental caries/
53	36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52

Search terms	
54	19 and 35 and 53
55	exp child/ or adolescent/
56	54 not 55
57	editorial.pt.
58	case reports.pt.
59	letter.pt.
60	57 or 58 or 59
61	56 not 60
62	limit 61 to (English language and yr="2009 -Current")

For peer review only

Table 2. Study selection criteria

Selection criteria	Inclusion	Exclusion
Population – Consumer	<p>1. General adult (18+) population with one or more diagnosed chronic health conditions as classified by the National Public Health Partnership (2001): Ischaemic heart disease (also known as coronary heart disease); Stroke; Lung cancer; Colorectal cancer; Depression; Type 2 diabetes; Arthritis; Osteoporosis; Asthma; Chronic obstructive pulmonary disease (COPD); Chronic kidney disease; Oral disease.</p> <p>Patients described as having multimorbidity (i.e. two or more chronic conditions).</p> <p>2. Participants classified as vulnerable based on IMPACT definition and of specific relevance to SWS including: Indigenous/first nation people, culturally and linguistically diverse (CALD) groups including recently arrived refugee groups, those experiencing socio-economic hardship and disadvantage (unemployed, low income, those in public housing, homeless); and geographic disadvantage (living in a rural and remote area).</p>	<p>Mixed populations of adult and children unless these groups have been separated as part of the analysis.</p> <p>Patients with mental health conditions which may impair cognition or understanding, such as dementia and psychosis.</p>
Population - practitioner	<p>Any health professional providing primary care to a community based population including general practitioner/family physician, practice nurse or community/clinic nurse, pharmacist, allied health professionals (Aboriginal Health Workers or Aboriginal and Torres Strait Islander Health Practitioners, Audiologists , Chiropractors , Diabetes Educators, Dietitians-, Exercise, Physiologists, Mental Health Workers, Occupational Therapists , Osteopaths, Physiotherapists, Podiatrists, Psychologists, Speech Pathologists).</p>	
e/m/telehealth interventions	<p>Comprehensive (multi-component) or simple (one component) patient directed or patient focused tools available via a personal computer, telephone, or mobile device (mobile phone or tablet). This includes the provision of instant feedback or SMS reminders which encourage patients to achieve their health goals and interactive programs which provide ongoing monitoring with self-assessment activities.</p> <p>Access to the tools should involve an initial direct interaction between a primary health care provider (defined above) and the patient (defined above) during which instruction or</p>	<p>e/m/telehealth intervention/s implied but not described</p> <p>Devices or programs used for simple self-monitoring of symptoms related to chronic condition such as sugar or blood pressure except where these are a component of a broader interactive intervention.</p> <p>Readings recorded via the internet or through devices which allow the download of readings. These may be included if they are one</p>

Selection criteria	Inclusion	Exclusion
	<p>training is provided to the patient to aid understanding, promote knowledge, or increase skills, including coaching and education tools provided over the phone.</p> <p>The intervention/tool should provide patients with a short to medium term OR ongoing interactive method of education, training or skill development that supports self-management and empowerment related to their management of chronic disease and its risk factors.</p>	<p>component of a more comprehensive self-management program.</p> <p>Telephone triage services where a patient is advised as to what level of care to seek (GP or hospital).</p> <p>Single contact for the provision of simple educational material only without added coaching/skill improvement and ongoing skill development.</p> <p>Telemedicine for routine consultations with no health education component/intention.</p> <p>Establishing, utilising or reviewing electronic health record systems within CBPHC</p>
Comparator	Usual care, enhanced usual care (e.g. added counselling or education) or a second intervention arm.	NA
Outcomes	<p>Primary outcomes:</p> <p>1. Health service use:</p> <ul style="list-style-type: none"> ❖ Increased attendance at PC service ❖ Number of GP visits per year ❖ Use of the e/m/telehealth intervention by patients and practitioners including practitioner adoption/inclusion in day to day practice or negative implications from use reported by patients or providers ❖ Satisfaction with service/practitioner care ❖ Decreased ED presentations ❖ Reduction in cost of providing PC ❖ Reduction in medication errors ❖ Reduction in adverse events including drug related events <p>2. Behavioural outcomes</p> <p>a) Patient behaviour</p> <ul style="list-style-type: none"> ❖ Number of patients with regular monitoring of their clinical parameters ❖ Number of people who self-report improvements in their management of chronic disease or risk factors ❖ Self-reported or measured change in level or risk/engagement in risk behaviour ❖ Levels of motivation 	

Selection criteria	Inclusion	Exclusion
	<ul style="list-style-type: none">❖ Levels of knowledge and/or understanding❖ Level of health literacy – self-reported or validated instruments❖ Level of e-health literacy – self reported or validated instrument❖ Self-efficacy❖ Level of confidence with self-management of their condition and associated risk factors❖ Self-reported or measured changes in communication/interaction with their PC provider❖ Quality of life <p>b) Practitioner behaviour</p> <ul style="list-style-type: none">❖ Enhanced use of tools/satisfaction with tools❖ Self-reported or measured increased patient communication <p>2. Secondary outcomes</p> <p>Health related outcomes</p> <ul style="list-style-type: none">❖ Compliance with treatment/medication❖ Decreased exacerbation of symptoms❖ Decreased mortality and morbidity❖ Negative outcomes from the use of the intervention/side effects	
Setting	<p>A community based primary health care setting such as general practice primary health care clinics, aboriginal health care centres; community health care clinics and after hours GP clinics within a hospital or any combination of these settings. This includes PHC services provided in a person’s home.</p> <p>Outpatient clinics such as cardiac rehabilitation and diabetes clinics (may be on or adjacent to a hospital site) if they cater for people residing in the community and provide valuable services for the management of chronic conditions.</p>	<p>Solely in-patient hospital based services.</p> <p>Non-health based settings i.e. gyms, private insurance companies etc.</p>

Table 3. Quality appraisal

Assessment of rigour	<ol style="list-style-type: none"> 1. Is there a clear statement of the aims of the research? 2. Did the study include an appropriate comparison group? 3. Did the study use appropriate eligibility criteria to obtain its target group? 4. Did the study use standardized methods for selecting/putting people into the study and state how they did this? 5. Did the study provide details about sample size? 6. Did the study have a comparatively long study period (≥ 6 months)? 7. Is the methodology appropriate for what they were trying to achieve?
Assessment of relevance	<ol style="list-style-type: none"> 1. Is the intervention program description detailed? 2. Did the study describe factors that affected program implementation? 3. Did the study consider reasons for the results that they achieved? 4. Did the study discuss reasons for program success or failure?

Based on: O'Campo P, Kirst M, Tsamis C, Chambers C, Ahmad F: Implementing successful intimate partner violence screening programs in health care settings: Evidence generated from a realist-informed systematic review. *Social Science & Medicine* 2011, 72(6):855-866.

Table 4. Telehealth studies

Study/country † = associated citations	Vulnerability/chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Dwight-Johnson 2011 [23] USA	Hispanic primary care patients with depression in rural Washington USA.	Telephone based CBT versus enhanced usual care	8 sessions of CBT by telephone. Patient given a workbook translated to Spanish. Sessions conducted by 5-part time Spanish speaking therapists with masters in social work	Satisfaction, symptom severity, use of medication, uptake /implementation	Moderate - Thin
Eakin 2009 [24] † ¹ Australia	Primary care patients within a socioeconomically disadvantaged region of Qld, Australia with multiple co-morbid chronic conditions.	Telephone counselling intervention (weight and physical activity) versus usual care	Mailed workbook with information on healthy eating and PA and a pedometer. 18 phone calls over 12 months from study counsellors. Calls went from bi-weekly to monthly and used the 4As approach (assessment and feedback, advice on PA and diet, assistance with goal setting and developing a personalised plan for modifying PA and diet according to guideline recommendations and arranging follow up support in the form of subsequent calls.	PA levels and diet, no meeting guideline recommendations, uptake/implementation	High - Thick
Eakin 2014 [25] Australia † ^{2,3}	Adult patients with Type 2 Diabetes from a socioeconomically disadvantaged area of Qld Australia	Telephone delivered weight loss intervention (Living well with Diabetes) versus usual care	Workbook and up to 27 telephone calls over 18 months. The telephone counsellor works with participants to encourage reduced energy intake by 2000kj per day and 30 minutes a day	No meeting program targets for diet, physical activity, weight loss, weight circumference, levels of	High - Thick

¹ Eakin, E.G., et al., *The Logan Healthy Living Program: A cluster randomized trial of a telephone-delivered physical activity and dietary behavior intervention for primary care patients with type 2 diabetes or hypertension from a socially disadvantaged community — Rationale, design and recruitment*. Contemporary Clinical Trials, 2008. **29**(3): p. 439-454.

² Eakin, E.G., et al., *Six-Month Outcomes from Living Well with Diabetes: A Randomized Trial of a Telephone-Delivered Weight Loss and Physical Activity Intervention to Improve Glycemic Control*. Annals of Behavioral Medicine, 2013. **46**(2): p. 193-203.

³ Eakin, E.G., et al., *Living Well with Diabetes: a randomized controlled trial of a telephone-delivered intervention for maintenance of weight loss, physical activity and glycaemic control in adults with type 2 diabetes*. BMC Public Health, 2010. **10**(1): p. 1-15.

Study/country † = associated citations	Vulnerability/chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
			of moderate-intensity, planned activity. Multi-modal behaviour therapies are used to promote self-monitoring, goal setting, problem solving, social support, stimulus control, positive self-talk and self-reward.	PA, uptake	
Gabrielian 2013 [26] USA	Previously homeless veterans with chronic disease who have been rehoused through US Dept. of Housing and Urban Development Supportive Housing Program (HUD-VASH).	Care Coordination Home Telehealth (CCHT) plus peer support for 'technology divide' versus usual care	CCHT - protocol driven in-home messaging and recording of daily monitoring transmitted via the phone and stratified according to three risk categories (colour coded) prompting a telephone call by RN where indicated Bi-weekly veteran support by peers	Feasibility, satisfaction	Weak - Thin
Gellis 2014 [27] USA	Medically frail older homebound individuals with COPD or CHF and co-morbid depression. Patients were recruited from a hospital affiliated home care agency, which services low-income people.	Integrated Telehealth Education and Activation Model (I-TEAM) versus usual care with in-home nursing plus psychoeducation	Tele monitoring for chronic illness and depression care management, and Problem Solving Therapy (PST) for comorbid depression. Patients were given an in home device to log symptoms and measurements daily. Nurses contacted for follow-up where required. Nurses provided brief PST over the phone for 8 weeks.	Symptom severity, no. of ED visits/days hospitalised, problem solving skills, satisfaction,	Moderate - Thin
Kahn 2009 [28] USA	Disadvantaged - Members of Gold Choice, a partially capitated Medicaid managed care program for individuals with diabetes and a behavioural health diagnosis	Telephonic nurse case management (TNCM) No comparison group	The TNCM monitors members with diabetes between office visits, provides diabetes counselling and facilitates self-care by reminding the patients about appointments, lab work and specialty referrals	Issues relating to implementation	Weak - Thin

Study/country † = associated citations	Vulnerability/chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Pickett 2014 [29] USA	Recently hospitalised older adults (>55yrs) in an urban acute care hospital with depression	Telephone facilitated depression care versus usual care	Those in the facilitated group were reassessed by telephone at 2,4,6,8 and 12 weeks, receiving techniques for problem solving, behavioural activation, self-management, monitoring response to treatment and countering premature discontinuation of medication	Initiation of medication/prescribing	Moderate - Thin
Sheldon 2014 [30] USA	Low income culturally diverse patients with depression attending any of 8 primary care clinics	Telephone Assessment Support and Counselling (TASC) Program No comparison group	Six telephone calls (one assessment and up to five therapy calls) covering behavioural activation (BA) for depression (form of CBT) and motivational interviewing strategies into medication adherence and depression counselling	Recruitment, engagement/retention, fidelity	Moderate - Thick
Wolf 2014 [22] USA	Patients with Type 2 diabetes attending federally qualified health centres designed to cater for underserved US communities.	Two intervention arms. 1. Carve in (clinic based) and 2. Carve out (outsourced telephone-based support)	Carve In – Patient diabetes guide, brief counselling and action plan with PCP with telephone FU at 2 weeks and 2 months. And via phone or in person at 3, 6 and 9 months. Carve out –Diabetes guide distributed by PCP and referral to telephone diabetes educator who facilitates action plan and follow up. Counselling provided by a research assistant. Patient followed up at same intervals as Carve-In, by diabetes educator	Knowledge/literacy, HbA1c, systolic BP and LDL cholesterol, uptake and satisfaction with service	Moderate - Thick

Table 5. eHealth and Telehealth studies

Study/country	Vulnerability/chronic disease	Intervention	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Cardoza 2010 [31] USA	Elderly patients following discharge from an inpatient setting with a diagnosis of HF, COPD, DM, or HTN	Case managed telemedicine (CMTM) No comparison group	Condition based instruments including a scale, digital BP, heart rate monitor, pulse oximeter, glucometer, and 'healthy buddy' - a telephone modem for information transmission monitored daily by a nurse. Failure to transmit data instigated a FU PC or home visit. Home visits averaging 1-3 a week for 60 days including review of condition, compliance, patient education Disease management software program tracked patients over time and symptom assessment was performed through patient care management system that recorded 9 quality of care indicators (pain, Dyspnoea, urinary incontinence, dressing, bathing, toileting, transferring, ambulation, medication management)	Re-hospitalisation and ED visits, compliance, quality of health perception, quality of care, mortality, satisfaction	Moderate/Thin
Chong 2012 [32] USA	Hispanic low income patients of a community health centre with major depression	Telepsychiatry services through the internet using a webcam versus usual care	Monthly telepsychiatry sessions at the CHC for 6 months provided by one of two Hispanic psychiatrists using an online virtual meeting program.	Symptom severity/incidence, Acceptability of telepsychiatry, feasibility of implementing a telepsychiatry program, satisfaction with care	Moderate/Thick

Study/country	Vulnerability/chronic disease	Intervention	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Davis 2011 [33] † ^{4,5} USA	Veterans from minority groups with depression	Telemedicine Enhanced Antidepressant Management (TEAM) study versus usual care	Stepped care model of depression treatment for up to 12 months. The offsite intervention team focused on optimizing pharmacotherapy. The RN used a scripted uniform protocol during telephone calls to pts to address treatment barriers and reasons for non-adherence and strategies for managing side effects. A pharmacist called pts who had not responded to treatment to provide management. Psychiatrists supervised the off-site team and provided consultations via interactive video/skype	Depression related PC encounters and unintended increase in non-depression related speciality PH encounters Response rate, Cost	Moderate/Thick
Fortney 2013 [21] USA	Medically underserved patients with depression attending 5 federally qualified rural health centres	Two intervention arms. 1. Practice based collaborative care 2. Telemedicine based collaborative care	1. Practice based collaborative care - Upskilled staff at clinic education/activation, self-management goal setting, 2. Telemedicine based collaborative care - F/T depression care manager - Stepped depression care based on protocols with medication management by pharmacist. Psychiatric consultation via video conferencing. CBT was provided by videoconferencing	No of PC and MH visits, levels of prescribing, response, remission, satisfaction, fidelity/uptake	Moderate/Thick
Shea 2009 [34] † ⁶	Older, ethnically diverse, Medicare beneficiaries	Telemedicine (IDEATel) versus usual care	Home telemedicine unit to videoconference with a diabetes	Physical impairment (PI), and physical	Moderate/Thick

⁴ Fortney, J.C., et al., *A Budget Impact Analysis of Telemedicine-based Collaborative Care for Depression*. Medical Care, 2011. **49**(9): p. 872-880.

⁵ Pyne, J.M., et al., *Cost-effectiveness analysis of a rural telemedicine collaborative care intervention for depression*. Archives of General Psychiatry, 2010. **67**(8): p. 812-821.

Study/country	Vulnerability/chronic disease	Intervention	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
USA	with diabetes living in federally designated underserved areas of New York state		educator every 4-6 weeks for self-management education, review of transmitted home blood glucose and blood pressure measurements and individualised goal setting. Access to special educational web page created for the project in both English and Spanish	activity (PA) and self-reported pedometer use. BP, HbA1c, chol	
Sheeran 2011 [35] USA	Patients over 65yrs with depression (English and Spanish speaking) who were enrolled in homecare with one of three homecare agencies (Vermont, NY and Florida)	Telemonitor based Depression Care Management (DCM) - Depression Tele-care Protocol No comparison group	The DCM (nurse or social worker) coordinates care between the patient, physician and mental health specialist. Telemonitors measure daily weight, blood sugar, heart rate etc. - chime (synthetic voice through speakers) or touch screen which prompts patients to enter measurements. They also ask simple questions about health and provide basic education. Protocol elements available in both Spanish and English. Nurses followed up patients by telephone as needed on care, education and to reassure patients and encourage pleasurable activities and assess depression status	Symptom severity, feasibility, acceptability and satisfaction	Moderate/Thick

⁶ Weinstock, R.S., et al., *Glycemic control and health disparities in older ethnically diverse underserved adults with diabetes: Five-year results from the Informatics for Diabetes Education and Telemedicine (IDEATel) study*. Diabetes Care, 2011. **34**(2): p. 274-279.

Table 6. Realist Matrix

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
Telehealth studies					
Eakin 2009 [24]	Unclear – based on the interaction between the study counsellor delivering the intervention and the patient	<p>Ethnically diverse patients with Type 2 Diabetes from a region on the outskirts of a state capital city in Australia.</p> <p>Comparatively elevated indicators of social disadvantage including a greater percentage of single-parent families, unemployment, and foreign born residents.</p> <p>Participants usually supported through a fee for service primary health care practice although intervention is home based and unsupervised</p> <p>Counselors (masters-level graduates with a background in nutrition) trained in physical activity promotion and motivational interviewing techniques</p>	<p>Detailed workbook to promote education on physical activity and healthy eating; pedometer.</p> <p>Telephone support providing assessment (and feedback); advice on physical activity and diet; assistance with goal setting and a personalised plan for modifying physical activity and diet</p> <p>Follow up support in the form of subsequent telephone contacts.</p>	Unknown	Behaviour change - increased physical activity and improved diet (decreased calories from fat and increased intake of fruit, vegetables and fiber)
Eakin 2014 [25]	Unclear – based on the interaction between the counsellor delivering the intervention and the	Ethnically diverse patients with Type 2 Diabetes from a region on the outskirts of a state capital city in Australia.	<p>Detailed patient workbook</p> <p>Accelerometer was worn by patients to collect PA data and record use of device</p>	<p>Unknown</p> <p>Authors propose that engagement and motivation of</p>	Behaviour change - Loss of weight, increase in moderate/vigorous physical activity (MVPA), and diet quality

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
	patient	<p>Comparatively elevated indicators of social disadvantage including a greater percentage of single-parent families, unemployment, and foreign born residents.</p> <p>Participants usually supported through a fee for service primary health care practice although intervention is home based and unsupervised</p>	<p>Motivational interviewing providing support and managing expectations; identifying health benefits of weight loss; setting goals for diet and PA; self-monitoring progress; focusing on achievements and rewards</p>	<p>participants was low and only motivated patients should be included in such programs</p>	<p>Improved clinical biomarkers - HbA1c, lipids and BP</p>
Sheldon 2014 [23]	Unclear – based on the interaction between the therapist delivering the intervention and the patient	<p>Low income, culturally diverse, medically underserved patients with depression in US (Medicaid)</p> <p>Self-nomination offered to patients through clinics and direct referral options by PCP</p> <p>Multidisciplinary contact, Therapists trained</p>	<p>Behavioural activation delivered as brief intervention to reduce self-punishment and increase positive reinforcement by teaching mood monitoring and social engagement (form of CBT).</p> <p>Protocol driven incorporating language skills to foster collaboration and motivation</p> <p>Motivational interviewing to enhance medication adherence</p> <p>Flexible timeframes for patients who were more difficult to re-direct – up to 75mins</p> <p>Pleasant activities list</p>	<p>Motivation – I want to talk about my problems and seek advice</p> <p>Doing things when I don't really feel like it will still help me achieve my goals</p> <p>Rapport with a 'warm and objective' therapist (this person understands my issues and is there to help me)</p> <p>'The self-help resources gives me a sense of purpose'</p>	<p>Improved engagement with depression management and increased self- management especially in relation to medication management leading to improved adherence</p>

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
				These skills will be useful in the future (skill mastery)	
Wolf 2014* [22]	Unclear – based on the interaction between the primary care clinic staff and the patient	Patients with Type 2 diabetes attending federally qualified health centres (urban, suburban and rural) designed to cater for underserved US communities	Carve in - Diabetes guide reviewed between patients and PC staff. Colourful 48-page Diabetes Guide tailored to low literacy levels (5 th grade level) with descriptive photographs to depict self-care concepts	Patient desire to have care provided within the PC practice as opposed to care from an outsourced service (even if more specialised)	Improved knowledge self-management for people with low health literacy
		Diabetes champion to deconstruct tasks and assign responsibilities to clinic staff	Patient engagement activities delivered by a nurse - Brief counselling intervention and action plans, iterative counselling process to identify individual behavioural goals that are easily attainable and increase their confidence		Improved access/uptake of service
		Clinic staff trained in counselling – teach back – positive encouragement, problem solving and coaching of patients to develop action plans	Tracking system to follow up patients		Improved clinical biomarkers- HbA1C, PB, cholesterol
		Semi-structured script to encourage standardised interactions with patients			Patient satisfaction
		No financial support received to sustain staff roles			
	Unclear – based on the interaction between	Practice re-design to incorporate brief diabetes education and counselling	Carve out - Diabetes guide reviewed between patients and diabetes educator	Authors propose that the outsourced intervention worked better for patients who had not reached	
		Referral to diabetes educator	Colourful 48-page diabetes		

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		<p>Trained research staff delivered counselling</p> <p>At the time of the intervention there had been an injection of state funding that had resulted in more resources than had been previously available</p>	<p>guide tailored to low literacy levels (5th grade level) with descriptive photographs to depict self-care concepts.</p> <p>Patient engagement activities delivered by diabetes educator - Brief counselling intervention and action plans, iterative counselling process to identify individual behavioural goals that are easily attainable and increase their confidence.</p>	<p>glycemic control to reach it, those who were stable remained well managed (goal attainment)</p>	
EHealth plus telehealth					
Chong 2012 [34]	Unclear – based on the interaction between the psychiatrist and patient	<p>Hispanic low income, uninsured patients with depression in a rural setting</p> <p>88% were women, married or with a partner. Low rates of education and employment. Poorer representation of men due to restriction from low level employment</p> <p>Patients oriented more to Mexican than to Anglo culture</p> <p>No previous treatment for mental health</p> <p>Telemedicine had been</p>	<p>Culturally compatible components – Hispanic speaking psychiatrists (one male, one female)</p> <p>Clinic housed in an agency located in the community – transport – easy to get there –</p> <p>Virtual meeting space</p>	<p>Patients said the program made them feel better and it helped me - feel supported</p>	<p>Increased access to depression management via culturally relevant service.</p> <p>Decrease in depression symptoms; improved medication adherence</p> <p>Patient satisfaction</p>

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		<p>operating within the clinic for some time (organisational readiness) and for 5yrs the clinic had been trying to increase access to depression treatment for patients</p> <p>No costs incurred by patients. care provided in a clinic - patients taken to telemedicine room from the recruiter's office and not directly from the waiting room to reduce stigma</p>			
Davis 2011 [35]	Unclear – based on the interaction between the clinic nurse/clinical pharmacist and patient	Veterans from minority groups in a rural setting with depression	Stepped care depression module with care escalated for those not responding to lower levels of care by involving more professionals with additional expertise	Unknown - authors propose these may relate to education and activation	Increased adherence to medication and better response to treatment
Fortney 2013* [21]	Unclear – based on the interaction between the PCP and on site nurse depression care manager and the patient	<p>Medically underserved population in a remote setting (Arkansas' Mississippi Delta, Ozark Highlands) with depression and numerous comorbidities</p> <p>High unemployment/lack of insurance</p> <p>Half time funded depression care manager (nurse) – no</p>	<p>Practice-based collaborative care</p> <p>Upskilled staff at clinic education/activation, self-management goal setting,</p>	Unknown – authors propose that patients were more likely to engage in self-management activities because the depression care manager (despite being off site) practiced a more intensive program and provided more	<p>Changes in depression severity, treatment response and remission</p> <p>Self-management</p> <p>Patient satisfaction</p>

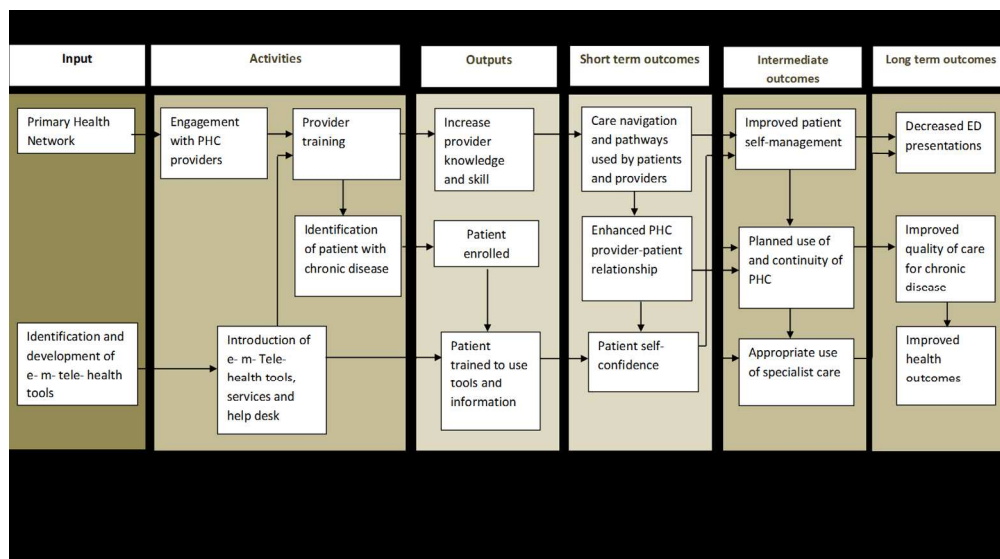
Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		<p>prior MH training but received study training</p> <p>Decision support used to guide treatment – no clinical supervision</p> <p>Patients could choose 'watchful waiting' or antidepressant treatment</p> <p>Patients preference for face to face or telephone encounters</p>		encouragement to undertake physical, rewarding and social activities	
	Unclear – based on the interaction between multiple PC providers, off-site depression care manager and patient	<p>Medically underserved population in a remote setting (Arkansas' Mississippi Delta, Ozark Highlands) with depression and numerous comorbidities</p> <p>High unemployment/lack of insurance</p> <p>Off-site team funded by study</p>	<p>Telemedicine based collaborative care</p> <p>Full time depression care manager</p> <p>CBT delivered by videoconferencing</p>		
Shea 2009 [36]	Unclear – based on the interaction between the off-site nurse manager and the patient	<p>Older ethnically diverse medically underserved patients with Type 2 Diabetes receiving Medicare</p> <p>¾ spoke primarily Spanish</p> <p>Nurses trained in computer</p>	<p>Web enabled computer and modem connection to existing telephone line – web cam and videoconferencing capacity</p> <p>Home glucometer, BP cuff connected to the telemedicine unit. Direct upload of data to</p>	Unknown	Improved clinical biomarkers – HBA1c, BP and LDL cholesterol

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		based case management tools and to facilitate interactions through videoconferencing PCPs kept full responsibility of intervention patients –tried to avoid disruption of relationships	clinical database Educational web page in English and Spanish and in regular or low literacy versions in each language		
Sheeran 2011 [37]	Unclear – based on the interaction between the telehealth nurse and patient	Ethnically diverse sample of older patients with depression – homebound Three Medicare certified home care agencies (urban, suburban and rural) Nurses trained on telehealth protocol	Spanish and English versions of tele-monitoring tools and materials Touch screen and/or synthetic voice to prompt patients – on-line interactive screen can ‘ask’ patients questions Basic education and behavioural activation/goal setting	I felt more connected to the agency The frequent checks from the tele-monitor were comforting, reassuring I better understood my depression I was able to be more honest about my feelings with a machine I don’t like using a machine to discuss my feelings Telemonitoring reduces the sense of stigma	Change in behaviour Satisfaction Reduction in depression severity

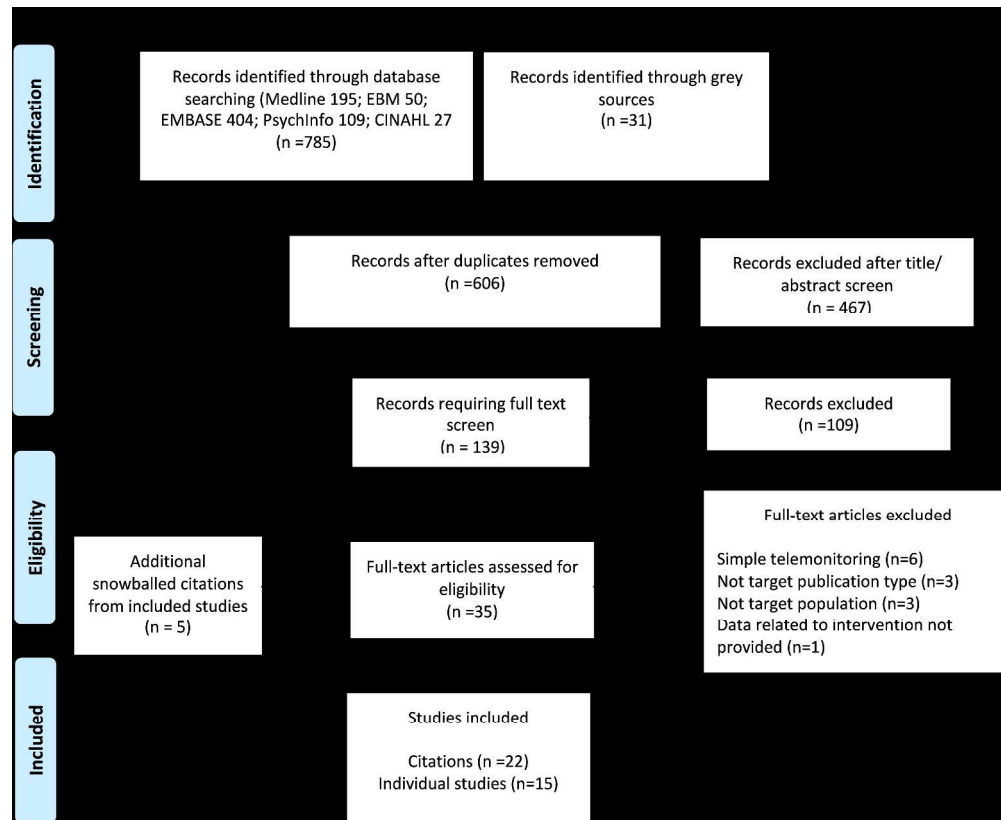
**Assesses two intervention arm*

Table 7. Characteristics of included studies

Study Characteristic	Number	Study Characteristic	Number
Design		Setting	
RCT	8	General practice	6
Cluster RCT	2	Community health	2
Quality Improvement	1	Supported veteran program	1
Observational	2	Outpatient program	1
Descriptive evaluation	1	Community home care	3
Qualitative	1	Federally funded health centres/Medicaid	2
Intervention		Geographical area	
Telehealth	9	United States	13
eHealth and telehealth	6	Australia	2
Chronic condition		Vulnerability	
Depression	7	Older age (>55yrs)	3
Diabetes	4	Low SES	9
Multi-morbidity	4	Homeless/supported accommodation	1
		Rural/low SES/underserved communities	2



448x248mm (96 x 96 DPI)



1218x994mm (96 x 96 DPI)



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE: Promoting self-management for vulnerable people with chronic conditions using electronic and telehealth tools: A systematic review and realist synthesis			
Title	1	Identify the report as a systematic review, meta-analysis, or both. Systematic review and realist synthesis	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3-4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5-6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Not registered Available from author
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Table 2
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. Quality assessment – rigour and relevance	8-9 and Table 3
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Realist matrix - 9



PRISMA 2009 Checklist

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	NA
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Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	10 and Figure 2
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Tables 4 and 5
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). Quality assessment – 'rigour and relevance'	Table 4 and 5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	NA
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	17
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19-20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	21



PRISMA 2009 Checklist

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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For peer review only

BMJ Open

Electronic, mobile and telehealth tools for vulnerable patients with chronic disease: A systematic review and realist synthesis

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Manuscript ID	bmjopen-2017-019192.R1
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Keywords:	telehealth, eHealth, chronic disease, long term conditions, vulnerable population, realist synthesis

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Manuscripts



Electronic, mobile and telehealth tools for vulnerable patients with chronic disease: A systematic review and realist synthesis

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On behalf of the IMPACT Study Group

Abstract

Objectives:

The objective of this review was to assess the benefit of using electronic, mobile and telehealth tools for vulnerable patients with chronic disease and explore the mechanisms by which these impact patient self-efficacy and self-management.

Design: We searched Medline, All EBM, CINAHL, EMBASE, and PsychINFO covering the period 2009 to 2018 for electronic, mobile or telehealth interventions. Quality was assessed according to rigour and relevance. Those studies providing a richer description ('thick') were synthesised using a realist matrix.

Setting and participants:

Studies of any design conducted in community based primary care involving adults with one or more diagnosed chronic health condition and vulnerability due to demographic, geographic, economic and/or cultural characteristics.

Results:

Eighteen trials were identified targeting a range of chronic conditions and vulnerabilities. The data provided limited insight into the mechanisms underpinning these interventions, most of which sought to persuade vulnerable patients into believing they could self-manage their conditions through improved symptom monitoring, education and support and goal setting. Patients were relatively passive in the interaction, and the level of patient response attributed to their intrinsic level of motivation. Health literacy, which may be confounded with motivation, was only measured in one study and eHealth literacy was not assessed.

Conclusions:

Research incorporating these tools with vulnerable groups is not comprehensive. Apart from intrinsic motivation, health literacy may also influence the reaction of vulnerable groups to technology. Social persuasion was the main way interventions sought to achieve better self-management. Efforts to engage patients by health care providers were lower than expected. Use of social networks or other eHealth mechanisms to link patients and provide opportunities for vicarious experience could be further explored in relation to vulnerable groups. Future research could also assess health and eHealth literacy and differentiate the specific needs for vulnerable groups when implementing health technologies.

Trial Registration: This systematic review is not registered.

Strengths and limitations of this study:

- The use of a comprehensive search and systematic process to identify both quantitative and qualitative data
- The use of Rameses and PRISMA reporting standards
- Incorporation of theory and mapping against a theoretical framework and realist matrix
- Limited data identified due to a lack of detailed context provided in the published studies

Keywords: family medicine, primary care, telehealth, e-health, chronic disease, vulnerable population

BACKGROUND

Chronic conditions result in significant personal and social burden [1]. Electronic and telehealth tools are increasingly commonplace, can be provided at relatively low cost [2], and incorporate personally relevant health information [3]. For those vulnerable and underserved community members with chronic or long term conditions, electronic applications may enhance the reach of health services and the provision of tailored need based services [4, 5]. The growing impetus to use these technologies is largely underpinned by their potential to intervene in the course of health care, and influence the way people deal with their health issues[6]. There is also an expectation that health technologies will engage consumers in appropriate self-care and self-management [7], which within the health delivery sphere, shifts the responsibility solely from the clinician, to one which is jointly shared by the health provider and patient.

Electronic health (eHealth) tools incorporate many opportunities for patients to increase their engagement through focused disease specific learning, options to receive regular feedback and frequent reinforcement (e.g. peripheral monitoring devices) [8]. In-built support functions which assess progress, provide goal setting and problem solving, aim to increase the patient’s skill and confidence in managing their health problems [9]. Supplementary motivational interviewing and cognitive behavioural components can also be provided via the internet, mobile device or telephone[10] .

The claims made by health-related apps, websites and other electronic tools remain largely unverified, and more specifically, little is known about their value for vulnerable and marginalised groups. Within the Innovative Models Promoting Access-to-Care Transformation (IMPACT) program, we aimed to assess, via a systematic review and realist synthesis, the perceived benefit of using electronic tools to enhance the engagement of vulnerable patients with chronic disease. We used

1
2
3 realist methodology as a way of unpacking the complexity surrounding eHealth interventions [11].
4
5 This methodology explains the interplay between context, mechanisms and outcomes [12] where
6
7 mechanisms are not activities within the intervention, but the responses by people that are
8
9 triggered by changes in context [13]. In this review, we specifically sought to explore mechanisms
10
11 related to patient self-efficacy and self-management. The impact of these tools on access to health
12
13 care more broadly, is the topic of a future manuscript.
14
15

16 17 18 19 **Research Question** 20 21

22
23 The objective of this review was to assess the benefit of using electronic, mobile and telehealth tools
24
25 for vulnerable patients with chronic disease, and to explore the mechanisms by which these tools
26
27 impact patient self-efficacy and self-management.
28
29

30
31 Our population of interest included adults with one or more diagnosed chronic health conditions.
32
33 We used the definition of chronic disease provided by the National Public Health Partnership [14]
34
35 framework, a seminal Australian resource setting out a strategic framework for the prevention and
36
37 control of chronic non-communicable diseases in Australia. This framework identified 12 chronic
38
39 conditions.
40
41

42
43 The definition of vulnerability was based on the IMPACT study definition: Indigenous/first nation
44
45 people, culturally and linguistically diverse (CALD) groups including recently arrived refugee groups,
46
47 those experiencing socio-economic hardship and disadvantage (unemployed, low income, those in
48
49 public housing, homeless), and geographic disadvantage (living in a rural and remote area). For these
50
51 population groups, these demographic, geographic, economic and/or cultural characteristics impede
52
53 or compromise access to community based primary health care.
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There are many and varied definitions of eHealth, mhealth and telehealth used across the health sector [1]. For the purpose of this review we defined these in the following ways:

- ❖ *Electronic health (**eHealth**), is the general transfer of health resources and health care by electronic means through the Internet and telecommunications [15].*
- ❖ *Mobile health (**mHealth**), is the delivery of healthcare services via mobile/wireless communication devices such as smartphones and tablets*
- ❖ ***Telehealth** describes the use of telecommunication techniques (voice, data, images) for providing telemedicine (remote clinical service delivery), medical education, and health education over a distance [16]. Telehealth encompasses long-distance clinical health care, patient and professional health-related education, public health and health administration.*

METHODS

Our processes were based on standard systematic review methodology [17]. Realist synthesis similarly follows the stages of a traditional systematic review except the appraisal of evidence is theoretically driven and intent on explaining why the intervention works or doesn't work [18]. Reporting has been guided by the Rameses publication standards for reporting realist synthesis [19] and the PRISMA statement [20].

We searched Medline, All Evidence Based Medicine (All EBM) CINAHL, EMBASE, and PsychINFO covering the period 1/1/2009 to 12/2/2018. Our basic search strategy (Table 1) was modified for use in each database.

Table 1. Search strategy conducted 12/2/2018 and modified for each database

Search terms	
1	telemedicine/
2	ehealth.mp.
3	E health.mp.
4	electronic health.mp.
5	internet health.mp.
6	mhealth.mp.
7	m health.mp.
8	mobile health.mp.
9	mobile health devices.mp.
10	social media/
11	telephone/
12	telehealth.mp.
13	tele health.mp.
14	telehomecare.mp.
15	text messaging/
16	exp therapy, computer-assisted/
17	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18	exp medical records systems, computerized/
19	17 not 18
20	primary health care/
21	exp family practice/
22	exp general practice/
23	exp physicians, family/
24	practice nurse.mp.
25	nutritionists/ or physical therapists/
26	pharmacists/
27	aboriginal health worker.mp.
28	audiologist.mp.
29	diabetes educator.mp.
30	exercise physiologist.mp.
31	occupational therapist.mp.
32	osteopathic physicians/
33	podiatrist.mp.
34	home care services/
35	20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34
36	chronic disease/
37	long term illness.mp.
38	long term condition.mp.
39	multimorbidity.mp.
40	multi morbidity.mp.
41	myocardial ischemia/
42	stroke/
43	lung neoplasms/
44	colorectal neoplasms/
45	exp depression/
46	diabetes mellitus, type 2/
47	arthritis/
48	pulmonary disease, chronic obstructive/
49	osteoporosis/
50	asthma/
51	renal insufficiency, chronic/
52	dental caries/
53	36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52

Search terms	
54	19 and 35 and 53
55	exp child/ or adolescent/
56	54 not 55
57	editorial.pt.
58	case reports.pt.
59	letter.pt.
60	57 or 58 or 59
61	56 not 60
62	limit 61 to (English language and yr="2009 -Current")

The criteria for study selection are described in detail in Table 2. We did not exclude studies based on design as we wanted to collect a richer understanding of the interventions.

Included studies required a description of the e/m/telehealth intervention and/or its components. Interventions which did not offer broader patient involvement through coaching/skill improvement components and ongoing skill development were excluded, including those programs used solely for simple self-monitoring of symptoms. Inpatient hospital-based services were excluded, as were those not presenting evaluative data, and those involving primarily children or adolescent populations.

We also selected only studies originating in Organisation for Economic Cooperation and Development (OECD) countries.

Table 2. Study selection criteria

Selection criteria	Inclusion	Exclusion
Population – Consumer	1. General adult (18+) population with one or more diagnosed chronic health conditions as classified by the National Public Health Partnership (2001): Ischaemic heart disease (also known as coronary heart disease); Stroke; Lung cancer; Colorectal cancer; Depression; Type 2 diabetes; Arthritis; Osteoporosis; Asthma; Chronic obstructive pulmonary disease (COPD); Chronic kidney disease; Oral disease. Patients described as having multi-morbidity (i.e. two or more chronic conditions).	Mixed populations of adult and children unless these groups have been separated as part of the analysis. Patients with mental health conditions which may impair cognition or understanding, such as dementia and psychosis.

Selection criteria	Inclusion	Exclusion
Population - practitioner	<p>2. Participants classified as vulnerable based on IMPACT definition and of specific relevance to SWS including: Indigenous/first nation people, culturally and linguistically diverse (CALD) groups including recently arrived refugee groups, those experiencing socio-economic hardship and disadvantage (unemployed, low income, those in public housing, homeless); and geographic disadvantage (living in a rural and remote area).</p> <p>Any health professional providing primary care to a community based population including general practitioner/family physician, practice nurse or community/clinic nurse, pharmacist, allied health professionals (Aboriginal Health Workers or Aboriginal and Torres Strait Islander Health Practitioners, Audiologists, Chiropractors, Diabetes Educators, Dietitians, Exercise, Physiologists, Mental Health Workers, Occupational Therapists, Osteopaths, Physiotherapists, Podiatrists, Psychologists, Speech Pathologists).</p>	
e/m/telehealth interventions	<p>Comprehensive (multi-component) or simple (one component) patient directed or patient focused tools available via a personal computer, telephone, or mobile device (mobile phone or tablet). This includes the provision of instant feedback or SMS reminders which encourage patients to achieve their health goals and interactive programs which provide ongoing monitoring with self-assessment activities.</p> <p>Access to the tools should involve an initial direct interaction between a primary health care provider (defined above) and the patient (defined above) during which instruction or training is provided to the patient to aid understanding, promote knowledge, or increase skills, including coaching and education tools provided over the phone.</p> <p>The intervention/tool should provide patients with a short to medium term OR ongoing interactive method of education, training or skill development that supports self-management and empowerment related to their management of chronic disease and its risk factors.</p>	<p>e/m/telehealth intervention/s implied but not described</p> <p>Devices or programs used for simple self-monitoring of symptoms related to chronic condition such as sugar or blood pressure except where these are a component of a broader interactive intervention.</p> <p>Readings recorded via the internet or through devices which allow the download of readings. These may be included if they are one component of a more comprehensive self-management program.</p> <p>Telephone triage services where a patient is advised as to what level of care to seek (GP or hospital).</p> <p>Single contact for the provision of simple educational material only without added coaching/skill improvement and ongoing skill development.</p> <p>Telemedicine for routine consultations with no health education component/intention.</p>

Selection criteria	Inclusion	Exclusion
		Establishing, utilising or reviewing electronic health record systems within CBPHC
Comparator	Usual care, enhanced usual care (e.g. added counselling or education) or a second intervention arm.	NA
Outcomes	<p>Primary outcomes:</p> <p>1. Health service use:</p> <ul style="list-style-type: none">❖ Increased attendance at PC service❖ Number of GP visits per year❖ Use of the e/m/telehealth intervention by patients and practitioners including practitioner adoption/inclusion in day to day practice or negative implications from use reported by patients or providers❖ Satisfaction with service/practitioner care❖ Decreased ED presentations❖ Reduction in cost of providing PC❖ Reduction in medication errors❖ Reduction in adverse events including drug related events <p>2. Behavioural outcomes</p> <p>a) Patient behaviour</p> <ul style="list-style-type: none">❖ Number of patients with regular monitoring of their clinical parameters❖ Number of people who self-report improvements in their management of chronic disease or risk factors❖ Self-reported or measured change in level or risk/engagement in risk behaviour❖ Levels of motivation❖ Levels of knowledge and/or understanding❖ Level of health literacy – self-reported or validated instruments❖ Level of e-health literacy – self reported or validated instrument❖ Self-efficacy❖ Level of confidence with self-management of their condition and associated risk factors❖ Self-reported or measured changes in communication/interaction with their PC provider❖ Quality of life <p>b) Practitioner behaviour</p> <ul style="list-style-type: none">❖ Enhanced use of tools/satisfaction with tools	

Selection criteria	Inclusion	Exclusion
	<ul style="list-style-type: none"> ❖ Self-reported or measured increased patient communication <p>2. Secondary outcomes</p> <p><i>Health related outcomes</i></p> <ul style="list-style-type: none"> ❖ Compliance with treatment/medication ❖ Decreased exacerbation of symptoms ❖ Decreased mortality and morbidity ❖ Negative outcomes from the use of the intervention/side effects 	
Setting	<p>A community based primary health care setting such as general practice primary health care clinics, aboriginal health care centres; community health care clinics and after-hours GP clinics within a hospital or any combination of these settings. This includes PHC services provided in a person's home.</p> <p>Outpatient clinics such as cardiac rehabilitation and diabetes clinics (may be on or adjacent to a hospital site) if they cater for people residing in the community and provide valuable services for the management of chronic conditions.</p>	<p>Solely in-patient hospital-based services.</p> <p>Non-health-based settings i.e. gyms, private insurance companies etc.</p>

Study selection process

Title and abstract screen was undertaken by at least two authors (SP, AP, LT). For citations requiring full text review, SP, AP and LT reviewed a subset of papers, with final inclusion determined through joint discussion and review.

Data extraction and study variables

Data was collected using a five page data collection form within an Access database incorporating the REAIM framework [21], the TiDieR Framework [22], the PROGRESS framework [23] and several pre-defined variables including study type, country of origin, the procedures, activities, and/or processes used in the interventions, supportive activities, recipients and the personnel involved in delivery of the intervention and reported study outcomes. All data extraction was conducted by two authors.

Quality appraisal

Within realist synthesis there is no accepted process for assessing quality. Pawson [12] argues that quality should not determine inclusion, but a realist synthesis should provide a ‘quality filter’ [24] which assesses the contribution of data to *rigour* (whether the method used to generate the data is credible and trustworthy), *and relevance* (whether it contributes to theory building and/or testing) [19].

We used a method described by O’Campo [25] due to recognition that the most useful study information may not be within the reports of studies with the highest quality. Studies were classified against the criteria (Table 3) by one author (SP) and confirmed by a second author (AP). Rigour was assessed as ‘high’, ‘moderate’ or ‘weak’ and plotted on a continuum from 0-7. One point was allocated for each positive response and studies graded as high (7 points), moderate (4-6 points) and low (0-3 points). Relevance was assessed based on ‘thick’ or ‘thin’ descriptions of the intervention components and their mechanisms. One point was allocated for each ‘yes’ answer and studies considered thick (3-4 points) or thin (0-2 points).

Table 3. Quality appraisal

Assessment of rigour	<ol style="list-style-type: none">1. Is there a clear statement of the aims of the research?2. Did the study include an appropriate comparison group?3. Did the study use appropriate eligibility criteria to obtain its target group?4. Did the study use standardized methods for selecting/putting people into the study and state how they did this?5. Did the study provide details about sample size?6. Did the study have a comparatively long study period (≥6 months)?7. Is the methodology appropriate for what they were trying to achieve?
Assessment of relevance	<ol style="list-style-type: none">1. Is the intervention program description detailed?2. Did the study describe factors that affected program implementation?3. Did the study consider reasons for the results that they achieved?4. Did the study discuss reasons for program success or failure?

Based on: O’Campo P, Kirst M, Tsamis C, Chambers C, Ahmad F: Implementing successful intimate partner violence screening programs in health care settings: Evidence generated from a realist-informed systematic review. *Social Science & Medicine* 2011, 72(6):855-866.

Realist Synthesis

At the core of realist synthesis is to make explicit the underlying assumptions as to how an intervention is supposed to work, and to then map the evidence in a systematic way to test and refine this theory [26]. We developed a linear logic model to explain the engagement of primary care providers and patients in the use of mobile, telehealth and eHealth tools (Figure 1). We explored known theories associated with patient self-efficacy and self-management and extracted data against a realist matrix using those included studies that had been assessed as providing a 'thick' description of the intervention. The matrix comprised documented results from each study plus relevant author discussion which attempted to place their results into context. Realist matrices are a complementary approach to outcome chains and other programme logic models. A realist matrix focuses on the causal mechanisms at work in a programme or project [27] and it helps to map the factors from a programme that may be contributing to outcomes by reflecting on:

- Agency: Whose actions exactly are causing the change to occur?
- Context: What are the external variables or 'moderators' that affect outcomes? including the impact of the social and political situation, broad social or geographic features, and different population profiles
- Resources: What resources have been provided or are available?
- Mechanism: How are the resources and the thing/person being changed interact?
- Outcome: What is the anticipated change relating to self-efficacy and self-management under the specified conditions?

Patient and Public involvement

Our research question was formulated through a collaborative process with the South-Western Sydney Local Innovative Partnership (LIP) comprising policy makers, healthcare providers and field experts involved in service provision to key vulnerable communities. We did not involve patients directly in this process.

RESULTS

From 1540 records initially identified, 1111 duplicates were removed and a further 869 excluded after title and abstract screening. Eligibility was frequently difficult to assess from the title and abstract, so 243 citations underwent a brief full text review, resulting in 192 exclusions. We identified nine additional related publications that were also eligible. Fifty- nine citations underwent data extraction. Thirty were excluded on the basis that they described simple tele-monitoring only, did not provide data related to the intervention, were of an incorrect publication type, or contained a population not meeting our definition of vulnerable. Twenty nine citations relating to eighteen separate studies were ultimately included (Figure 2) [20].

Randomised controlled trials (RCTs) and cluster RCTs were the predominant study types. Two studies compared alternative interventions [28, 29].

Appraisal of studies for rigour and relevance

Generally, studies were of moderate to high rigour (15/18 studies), and 12/18 studies provided additional valuable contextual information (Tables 4 to 7).

Table 4. Telehealth studies

Study/country † = associated citations	Vulnerability/chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Dwight-Johnson 2011 USA	Hispanic primary care patients with depression in rural Washington USA.	Telephone based CBT versus enhanced usual care	8 sessions of CBT by telephone. Patient given a workbook translated to Spanish. Sessions conducted by 5-part time Spanish speaking therapists with a master's in social work	Satisfaction, symptom severity, use of medication, uptake /implementation	Moderate - Thin
Eakin 2009 † ¹ Australia	Primary care patients within a socioeconomically disadvantaged region of Qld, Australia with multiple co-morbid chronic conditions.	Telephone counselling intervention (weight and physical activity) versus usual care	Mailed workbook with information on healthy eating and PA and a pedometer. 18 phone calls over 12 months from study counsellors. Calls went from bi-weekly to monthly and used the 4As approach (assessment and feedback, advice on PA and diet, assistance with goal setting and developing a personalised plan for modifying PA and diet according to guideline recommendations and arranging follow up support in the form of subsequent calls.	PA levels and diet, no meeting guideline recommendations, uptake/implementation	High - Thick
Eakin 2014 Australia † ^{2,3}	Adult patients with Type 2 Diabetes from a socioeconomically disadvantaged area of Qld Australia	Telephone delivered weight loss intervention (Living well with Diabetes) versus usual care	Workbook and up to 27 telephone calls over 18 months. The telephone counsellor works with participants to encourage reduced energy intake by 2000kj per day and 30 minutes a day	No meeting program targets for diet, physical activity, weight loss, weight circumference, levels of	High - Thick

¹ Eakin, E.G., et al., *The Logan Healthy Living Program: A cluster randomized trial of a telephone-delivered physical activity and dietary behavior intervention for primary care patients with type 2 diabetes or hypertension from a socially disadvantaged community — Rationale, design and recruitment*. Contemporary Clinical Trials, 2008. **29**(3): p. 439-454.

² Eakin, E.G., et al., *Six-Month Outcomes from Living Well with Diabetes: A Randomized Trial of a Telephone-Delivered Weight Loss and Physical Activity Intervention to Improve Glycemic Control*. Annals of Behavioral Medicine, 2013. **46**(2): p. 193-203.

³ Eakin, E.G., et al., *Living Well with Diabetes: a randomized controlled trial of a telephone-delivered intervention for maintenance of weight loss, physical activity and glycaemic control in adults with type 2 diabetes*. BMC Public Health, 2010. **10**(1): p. 1-15.

Study/country † = associated citations	Vulnerability/chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
			of moderate-intensity, planned activity. Multi-modal behaviour therapies are used to promote self-monitoring, goal setting, problem solving, social support, stimulus control, positive self-talk and self-reward.	PA, uptake	
Gabrielian 2013 USA	Previously homeless veterans with chronic disease who have been rehoused through US Dept. of Housing and Urban Development Supportive Housing Program (HUD-VASH).	Care Coordination Home Telehealth (CCHT) plus peer support for 'technology divide' versus usual care	CCHT - protocol driven in-home messaging and recording of daily monitoring transmitted via the phone and stratified according to three risk categories (colour coded) prompting a telephone call by RN where indicated Bi-weekly veteran support by peers	Feasibility, satisfaction	Weak - Thin
Gellis 2014 USA	Medically frail older homebound individuals with COPD or CHF and co-morbid depression. Patients were recruited from a hospital affiliated home care agency, which services low-income people.	Integrated Telehealth Education and Activation Model (I-TEAM) versus usual care with in-home nursing plus psychoeducation	Tele monitoring for chronic illness and depression care management, and Problem-Solving Therapy (PST) for comorbid depression. Patients were given an in-home device to log symptoms and measurements daily. Nurses contacted for follow-up where required. Nurses provided brief PST over the phone for 8 weeks.	Symptom severity, no. of ED visits/days hospitalised, problem solving skills, satisfaction,	Moderate - Thin
Kahn 2009 USA	Disadvantaged - Members of Gold Choice, a partially capitated Medicaid managed care program for individuals with diabetes and a behavioural health diagnosis	Telephonic nurse case management (TNCM) No comparison group	The TNCM monitors members with diabetes between office visits, provides diabetes counselling and facilitates self-care by reminding the patients about appointments, lab work and specialty referrals	Issues relating to implementation	Weak - Thin

Study/country † = associated citations	Vulnerability/chronic disease	Intervention and comparator	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Pickett 2014 USA	Recently hospitalised older adults (>55yrs) in an urban acute care hospital with depression	Telephone facilitated depression care versus usual care	Those in the facilitated group were reassessed by telephone at 2,4,6,8 and 12 weeks, receiving techniques for problem solving, behavioural activation, self-management, monitoring response to treatment and countering premature discontinuation of medication	Initiation of medication/prescribing	Moderate - Thin
Sheldon 2014 USA	Low income culturally diverse patients with depression attending any of 8 primary care clinics	Telephone Assessment Support and Counselling (TASC) Program No comparison group	Six telephone calls (one assessment and up to five therapy calls) covering behavioural activation (BA) for depression (form of CBT) and motivational interviewing strategies into medication adherence and depression counselling	Recruitment, engagement/retention, fidelity	Moderate - Thick
Wolf 2014 USA	Patients with Type 2 diabetes attending federally qualified health centres designed to cater for underserved US communities.	Two intervention arms. 1. Carve in (clinic based) and 2. Carve out (outsourced telephone-based support)	Carve In – Patient diabetes guide, brief counselling and action plan with PCP with telephone FU at 2 weeks and 2 months. And via phone or in person at 3, 6 and 9 months. Carve out –Diabetes guide distributed by PCP and referral to telephone diabetes educator who facilitates action plan and follow up. Counselling provided by a research assistant. Patient followed up at same intervals as Carve-In, by diabetes educator	Knowledge/literacy, HbA1c, systolic BP and LDL cholesterol, uptake and satisfaction with service	Moderate - Thick

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Table 5. eHealth and Telehealth studies

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Cardoza 2010 USA	Elderly patients following discharge from an inpatient setting with a diagnosis of HF, COPD, DM, or HTN	Case managed telemedicine (CMTM) No comparison group	Condition based instruments including a scale, digital BP, heart rate monitor, pulse oximeter, glucometer, and 'healthy buddy' - a telephone modem for information transmission monitored daily by a nurse. Failure to transmit data instigated a FU PC or home visit. Home visits averaging 1-3 a week for 60 days including review of condition, compliance, patient education Disease management software program tracked patients over time and symptom assessment was performed through patient care management system that recorded 9 quality of care indicators (pain, Dyspnoea, urinary incontinence, dressing, bathing, toileting, transferring, ambulation, medication management)	Re-hospitalisation and ED visits, compliance, quality of health perception, quality of care, mortality, satisfaction	Moderate/Thin
Cherrington 2015 USA + ^{4 5}	Low income African American patients from safety net neighbourhoods with poorly controlled Type 2 Diabetes plus peer	Diabetes Connect web application and telephone coaching and goal setting provided by peer	Diabetes Connect web application which allowed for communication between the CHW, the patient and the Diabetes team.	Process outcomes from web-based application (number of contacts, number of goals set.	Moderate/Thick

⁴ Crabtree, K., et al. (2015). "Diabetes Connect: African American Men's Preferences for a Community-based Diabetes Management Program." *The Diabetes Educator* **41**(1): 118-126.

⁵ Richardson, B. S., et al. (2015). "Diabetes Connect: African American Women's Perceptions of the Community Health Worker Model for Diabetes Care." *Journal of Community Health* **40**(5): 905-911.

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
	support Community Health Workers who either also had Type 2 Diabetes or cared for someone with diabetes	support Community Health Workers (CHW)	<p>The web application consisted of three core features:</p> <ol style="list-style-type: none"> 1. Contact tracking and call reminder system; 2. Secure communication system; 3. Progress reports. <p>CHWs were allocated to patients and provided telephone coaching and goal setting to patients via telephone (weekly for 3 months and monthly for another 3 months). They also held a monthly support/education group and tracked patient progress over time and linked them with the Diabetes Health Team and acted as a mediator between the patient and primary care.</p> <p>Self-management education was provided by the CHW through group/telephone and face to face interactions. CHW's were trained in communication, problem solving, goal setting, motivational interviewing (24 hrs) and via online modules on group facilitation, basic research and confidentiality</p>	Qualitative feedback regarding CHW roles, goals and challenges and feedback about messaging system and tracking of patients. Barriers to patient self-management;	
Chong 2012 USA	Hispanic low-income patients of a community health centre with major depression	Telepsychiatry services through the internet using a webcam versus usual care	Monthly telepsychiatry sessions at the CHC for 6 months provided by one of two Hispanic psychiatrists using an online virtual meeting program.	Symptom severity/incidence, Acceptability of telepsychiatry, feasibility of implementing a	Moderate/Thick

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
				telepsychiatry program, satisfaction with care	
Davis 2011 ^{†6,7} USA	Veterans from minority groups with depression	Telemedicine Enhanced Antidepressant Management (TEAM) study versus usual care	Stepped care model of depression treatment for up to 12 months. The offsite intervention team focused on optimizing pharmacotherapy. The RN used a scripted uniform protocol during telephone calls to pts to address treatment barriers and reasons for non-adherence and strategies for managing side effects. A pharmacist called pts who had not responded to treatment to provide management. Psychiatrists supervised the off-site team and provided consultations via interactive video/skype	Depression related PC encounters and unintended increase in non-depression related speciality PH encounters Response rate, Cost	Moderate/Thick
Fortney 2013 USA	Medically underserved patients with depression attending 5 federally qualified rural health centres	Two intervention arms. 1. Practice based collaborative care 2. Telemedicine based collaborative care	1. Practice based collaborative care - Upskilled staff at clinic education/activation, self-management goal setting, 2. Telemedicine based collaborative care - F/T depression care manager - Stepped depression care based on protocols with medication management by pharmacist. Psychiatric consultation via video conferencing. CBT was provided by videoconferencing	No of PC and MH visits, levels of prescribing, response, remission, satisfaction, fidelity/uptake	Moderate/Thick

⁶ Fortney, J.C., et al., *A Budget Impact Analysis of Telemedicine-based Collaborative Care for Depression*. Medical Care, 2011. **49**(9): p. 872-880.

⁷ Pyne, J.M., et al., *Cost-effectiveness analysis of a rural telemedicine collaborative care intervention for depression*. Archives of General Psychiatry, 2010. **67**(8): p. 812-821.

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Shea 2009 [30] † ^{8 9} USA	Older, ethnically diverse, Medicare beneficiaries with diabetes living in federally designated underserved areas of New York state	Telemedicine (IDEATel) versus usual care	Home telemedicine unit to videoconference with a diabetes educator every 4-6 week for self-management education, review of transmitted home blood glucose and blood pressure measurements and individualised goal setting. Access to special educational web page created for the project in both English and Spanish	Physical impairment (PI), and physical activity (PA) and self-reported pedometer use. BP, HbA1c, cholesterol	Moderate/Thick
Sheeran 2011 USA	Patients over 65yrs with depression (English and Spanish speaking) who were enrolled in homecare with one of three homecare agencies (Vermont, NY and Florida)	Telemonitor based Depression Care Management (DCM) - Depression Tele-care Protocol No comparison group	The DCM (nurse or social worker) coordinates care between the patient, physician and mental health specialist. Telemonitors measure daily weight, blood sugar, heart rate etc. - chime (synthetic voice through speakers) or touch screen which prompts patients to enter measurements. They also ask simple questions about health and provide basic education. Protocol elements available in both Spanish and English. Nurses followed up patients by telephone as needed on care, education and to reassure patients	Symptom severity, feasibility, acceptability and satisfaction	Moderate/Thick

⁸ Weinstock, R.S., et al., *Glycemic control and health disparities in older ethnically diverse underserved adults with diabetes: Five-year results from the Informatics for Diabetes Education and Telemedicine (IDEATel) study*. Diabetes Care, 2011. **34**(2): p. 274-279.

⁹ Izquierdo, R. E., et al. (2015). "Case Management with a Diabetes Team Using Home Telemedicine: Acceptance of Treatment Recommendations by Primary Care Providers in IDEATel." *Telemedicine journal and e-health: the official journal of the American Telemedicine Association* **21**(12): 980-986.

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Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
			and encourage pleasurable activities and assess depression status		

For peer review only

Table 6. mHealth studies

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Wayne 2015 Canada ¹⁰	Low SES community (multi-racial) with Type 2 Diabetes	Cloud based platform for mobile phone/software-based health management plus smartphone-based health coaching technology	<p>Participants received a Samsung Galaxy Ace II mobile phone running Google Android Ice Cream Sandwich (Android 4.0.2) with a data-only carrier plan.</p> <p>Patients received a user account with the Connected Wellness Platform (CWP) provided by NexJ Systems, which supported participants in health-related goal setting and progress monitoring. This allowed individual tracking of key metrics, (blood glucose levels, exercise frequency/duration/intensity, food intake (via photo journaling), and mood). HC primarily focused on planning to reach health targets, exercise (frequency, duration and intensity) and modifying diet to to reduce carbohydrate intake. T</p> <p>Communication with the HC 24/7 via secure messaging, scheduled phone contact, and/or during in-person meetings. Health data from the CWP were immediately visible to HC's through a secure, Web-accessible</p>	HbA1c levels, weight, BMI, waist circumference, psychometric assessment (satisfaction, QoL, Mood)	High/Thick

¹⁰ Pludwinski, S., et al. (2016). "Participant experiences in a smartphone-based health coaching intervention for type 2 diabetes: A qualitative inquiry." *Journal of Telemedicine and Telecare* **22**(3): 172-178.

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
			portal. Participant data and software-enabled communication required two-way certificate-based authentication and passwords that were stored in encrypted columns. Based on patient's goals, HC's used the 24-hour/day logging function to guide healthy lifestyle choices, while providing support when clients diverged from intended health goals and routines. Concurrent Exercise education program with trainers and blood glucose testing before and after exercise sessions		

Table 7. mHealth and eHealth studies

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
Davis 2015	Underserved, Low SES, English and Spanish speaking patients with a primary diagnosis of COPD or HF.	Remote monitoring device(RMD) which could use either landline or wireless technology. The RMD allowed patients to enter symptom related data such as pulse oximetry, heart rate, weight. The RMD was also pre-programmed with a set of questions that verbally transmitted in English and Spanish targeted to symptomatology.	<p>Integrated mobile health technology and home visits.</p> <p>The Remote Monitoring Device (RMD) operated on landline or wireless systems. The RMD was customised based on disease severity and allowed patients to enter symptom related data such as pulse oximetry, heart rate, weight. It consisted of a pre-programmed set of questions that were verbally transmitted in English or Spanish and targeted to COPD or HF symptomatology which were answered yes or no by pushing specific buttons on the device. The RMD also included an interactive educational component in which information was verbally transmitted to the patient with tips on symptom management. Acute changes in symptomatology triggered an acute alert that was directly communicated to the RMD monitoring staff for immediate response.</p> <p>The intervention included a phone call made to the patients by RMD staff or primary care based on patient answers. During this call symptoms were discussed, management reviewed, education provided and the physician</p>	<p>Emergency Department use within 30 days of discharge</p> <p>Re-admission rates</p> <p>Functional status</p> <p>Satisfaction</p>	Moderate/Thick

Study/country	Vulnerability/chronic disease	Intervention description	Components and delivery of the intervention	Outcomes assessed	Rigour/relevance
			<p>contacted if required. Phone calls were prompted if the patient had made no contact in three days.</p> <p>Home visits were made to set up the device within one week of discharge. Patients were also trained to use the device. Medication and functional status was assessed, and a personal health plan developed, including follow up by the physician. Additional home visits were triggered to perform symptom review and as required up until 90 days from enrolment.</p>		

Assessment of self-efficacy and self-management from study reported outcomes

Studies predominantly assessed a range of clinical and functional outcomes. Several proxy outcomes (that might reasonably be used to make assumptions about the effect on self-efficacy and self-management) were included such as feasibility, satisfaction and acceptability (Tables 4 to 7). Several studies reported positive changes in health behaviour (improved lifestyle indicators), increased compliance and adherence to lifestyle goals, and satisfaction with services.

From our logic model, we anticipated that access to reliable electronic tools, supported through a health care environment, would enhance patients' ability to obtain, process, and understand relevant health information (health literacy), thereby improving efficacy and their capacity to self-manage their chronic condition. The information provided by the studies was inconclusive as to whether this was achieved. Only one study [29] actively assessed health literacy and tailored their intervention accordingly. No studies assessed e-health literacy.

Overall satisfaction with the use of eHealth and telehealth tools by patients was generally positive. Satisfaction was directly related to the participant's perceived relevance of the tools and the level of positivity in the relationship with the intervention provider. In two studies [31, 32] patients expressed high levels of satisfaction from their interaction with nurses which promoted better understanding of their condition. Others showed high levels of willingness among patients to use tele-monitoring equipment (95%) and recommend it to others (90%) or pay for telehealth services [33] and a sense that equipment helped them to monitor and improve their health [34].

Theoretical basis for the interventions

For most studies, the choice of intervention had no documented theoretical basis. Interventions developed from either a supporting rationale or belief in the benefit of the intervention. These broad principles or frameworks surrounded equitable access, evidence-based medicine, quality

improvement, cost effectiveness, better disease management (chronic care and transitional models) and the improvement of health literacy. Only two associated studies specifically commented on the theoretical basis underpinning their intervention [35, 36]. This incorporated motivational interviewing “grounded in social cognitive theory constructs of self-efficacy, social support and outcome expectancies, which emphasized the building of participant skills in behaviour change strategies”.

Theory Mapping

We used theory to explore how electronic, mobile and telehealth interventions might influence an individual’s response (through learning and behaviour change) towards self-efficacy and self-management. Self-efficacy and self-management are interwoven concepts. Self-efficacy is the sense of patient confidence in their ability to exert control over their own motivation, behaviour, and social environment, and self-management is active participation by the patient in their own healthcare.

The theory of self-efficacy stems from social cognitive theory and describes the interaction between behavioural, personal, and environmental factors in relation to health and chronic disease [37]. Confidence in the ability to perform specific health behaviours will subsequently influence which behaviours patients will engage in [37-39], and is an important driver of sustained behaviour change [8].

The components of self-efficacy theory that influences actions are performance accomplishments, vicarious experience, social persuasion and physiological and emotional states[40]. From our matrix (Table 8), the study interventions used a range of resources designed to increase patient skill mastery such as assessment and feedback [35], goal setting [28, 29, 35, 36, 41, 42], workbooks [29, 35, 36], websites and training to use tools [34, 42-44]. Additional resource materials which

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3 encouraged participation, or guided participants through the intervention process were frequently
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5 provided and translated [33, 43].
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9 Mastery with the 'technology divide' was in-built in some interventions but not all. Self-efficacy can
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11 be enhanced by observing and interacting with those who have had similar experiences (i.e via
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13 vicarious experience). When we observe others succeed through sustained effort (e.g lose weight),
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15 this raises our beliefs that we too possess the capabilities to master the activities needed for success
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17 in that area.
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21 Within the included studies vicarious experience was not overtly targeted with the exception of the
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23 study by Cherrington [41] which used peer community health workers (with diabetes or caring for
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25 someone with diabetes) to link patients with diabetes to primary care via a web application and
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34 The largest concentration of effort within the interventions related to social persuasion or those
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36 activities where people are led, through suggestion, into believing that they can achieve a task. This
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38 was provided through motivational interviewing to manage expectations [36, 41], behavioural
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40 activation approaches [28, 34, 41, 42, 45] and counselling [29, 45]. Activities were purposefully
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42 designed to provide encouragement (e.g. goal setting), were easily attainable and focused on
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44 achievements and rewards [36]. Physical and/or psychological morbidities were common among the
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46 populations, and due to the negative judgements and emotional reactions that go hand in hand with
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48 these conditions, significant effort within the interventions targeted cognitive behavioural pursuits,
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50 reframing, and increasing positive experiences and pleasurable activities.
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Contextual factors identified

There was extensive contextual heterogeneity among the interventions (Table 9). Patients were enrolled from a range of primary care settings (general practice; community health; supported veteran programs; outpatient programs; community home care and US federally funded health centres/Medicaid). The interventions were overwhelmingly home based and some unsupervised. Interventions targeted populations with a range of chronic conditions and vulnerabilities (older age >55yrs, low socioeconomic status (SES), difficulties with accommodation (previously homeless persons in supported accommodation, and rural communities with a mixture of lower socioeconomic and underserved populations). Studies largely were artificial environments where intervention providers were put in place specifically for the period of the research. In some studies, it was not possible to know the degree to which routine clinical/service staff were incorporated into the delivery of the intervention. Some services ‘tagged’ interventions onto existing service structure and in many cases extra services and staff were temporarily employed to conduct interventions. Only one study [33] had a system of ‘organisational readiness’ where significant time had been spent developing a mental health service that could provide depression treatment to patients.

Interactions involved a range of primary care providers (nurses, counsellors, diabetes educators, pharmacists, lay/peer workers). Although providers were predominantly nurses operating in a variety of roles there was no evidence that this was associated with a different outcome to that of other providers. Surprisingly, general practitioners (GPs) (or their equivalents) did not deliver any of the interventions so no conclusions could be drawn about their role in delivering or negotiating these interventions with patients. Interventions were additional to the care of the GP or compared to the usual care provided by the GP. In some cases, enhanced usual care was utilised and in others the GP was peripheral to the main intervention activity in that they prescribed medications or reviewed guidelines with the patient or participated in dialogue with the intervention staff over management.

Nine studies were sub-categorised as providing a purely telehealth intervention, seven combined eHealth elements with telehealth, one was a mix of mHealth and eHealth and one was predominantly mHealth (Tables 4 to 7). All but one study provided a telephone- based service. Interventions were all multi-component and designed to address one or more health disparity for underserved populations. In addition to telephone or video support, interventions provided a varied range of additional components including, but not limited to: in home devices with prompts (6 studies); self-management education (15 studies); brief counselling (7 studies); ancillary patient devices (e.g. pedometers, BP cuffs, blood glucose monitors) (6 studies); paper or electronic patient information resources (9 studies); medication management (7 studies); stepped care (2 studies) and bilingual providers (4 studies).

Mechanisms

Within realist synthesis, a mechanism is a response that is triggered by changes in context [13]. Given the contextual heterogeneity it was not possible to clearly identify these reactions.

The level of an individual's 'motivation' or 'activation' was one possible mechanism prompting patients to respond either positively or negatively to the situations in which the intervention was employed [36, 45]. Feelings of 'being supported' [33, 41, 45]; having 'a sense of purpose' [45], experiencing 'a sense of achievement' [45], and the sharing of experiences [34] are interwoven reactions that may serve to motivate people. It was difficult to know how the level of rapport/interaction between patient and provider contributed in these instances, although it was highlighted as an important contributor in some studies [28, 34, 44, 45], and is a well-recognised enabling factor in self-efficacy and self-management programs generally.

One study suggested that patients with limited motivation should be excluded from these types of interventions [36], instead of providing efforts to 'kick start' motivation. Intuitively being motivated

to seek assistance is a major driver in this process, but it is also a complex reaction in this type of population. Low levels of health literacy can affect the degree to which a person is motivated to act and equally low motivation can be construed as low health literacy. Only one study measured and/or categorised participants by their health literacy level [29]. It is therefore not possible to comment how the levels of health literacy (or e-health literacy) influenced participant response.

Other contributing factors

Despite a strong underlying certitude around the value of the interventions to produce improvements in patient self-efficacy and self-management, we identified from the studies a tendency for the intervention provider to be the dominant player within the interaction, and the patient a more passive participant.

Studies reported several barriers to the use and uptake of tools by patients. These included a general unease or mistrust with the use of technology [43, 44] and a preference for face to face contact on the part of patients [33]; and pressures of added workloads [45], reduced time and inadequate skills on the part of clinicians to take on additional roles [35]. We found less age- related barriers in this review with elderly populations equally satisfied if interventions were well designed, user friendly, and supported. We anticipated that the most significant enabling factor would be patient training. However overall, we found the information relating to patient education and training to be sparse.

Table 8. Realist Matrix

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
Telehealth studies					
Eakin 2009	Unclear – based on the interaction between the study counsellor delivering the intervention and the patient	<p>Ethnically diverse patients with Type 2 Diabetes from a region on the outskirts of a state capital city in Australia.</p> <p>Comparatively elevated indicators of social disadvantage including a greater percentage of single-parent families, unemployment, and foreign-born residents.</p> <p>Participants usually supported through a fee for service primary health care practice although intervention is home based and unsupervised</p> <p>Counselors (masters-level graduates with a background in nutrition) trained in physical activity promotion and motivational interviewing techniques</p>	<p>Detailed workbook to promote education on physical activity and healthy eating; pedometer.</p> <p>Telephone support providing assessment (and feedback); advice on physical activity and diet; assistance with goal setting and a personalised plan for modifying physical activity and diet</p> <p>Follow up support in the form of subsequent telephone contacts.</p>	Unknown	Behaviour change - increased physical activity and improved diet (decreased calories from fat and increased intake of fruit, vegetables and fiber)
Eakin 2014	Unclear – based on the interaction between the counsellor delivering the intervention and the	Ethnically diverse patients with Type 2 Diabetes from a region on the outskirts of a state capital city in Australia.	<p>Detailed patient workbook</p> <p>Accelerometer was worn by patients to collect PA data and record use of device</p>	<p>Unknown</p> <p>Authors propose that engagement and motivation of</p>	Behaviour change - Loss of weight, increase in moderate/vigorous physical activity (MVPA), and diet quality

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
	patient	<p>Comparatively elevated indicators of social disadvantage including a greater percentage of single-parent families, unemployment, and foreign-born residents.</p> <p>Participants usually supported through a fee for service primary health care practice although intervention is home based and unsupervised</p>	Motivational interviewing providing support and managing expectations; identifying health benefits of weight loss; setting goals for diet and PA; self-monitoring progress; focusing on achievements and rewards	participants was low and only motivated patients should be included in such programs	Improved clinical biomarkers - HbA1c, lipids and BP
Sheldon 2014	Unclear – based on the interaction between the therapist delivering the intervention and the patient	<p>Low income, culturally diverse, medically underserved patients with depression in US (Medicaid)</p> <p>Self-nomination offered to patients through clinics and direct referral options by PCP</p> <p>Multidisciplinary contact, Therapists trained</p>	<p>Behavioural activation delivered as brief intervention to reduce self-punishment and increase positive reinforcement by teaching mood monitoring and social engagement (form of CBT).</p> <p>Protocol driven incorporating language skills to foster collaboration and motivation</p> <p>Motivational interviewing to enhance medication adherence</p> <p>Flexible timeframes for patients who were more difficult to re-direct – up to 75mins</p> <p>Pleasant activities list</p>	<p>Motivation – I want to talk about my problems and seek advice</p> <p>Doing things when I don't really feel like it will still help me achieve my goals</p> <p>Rapport with a 'warm and objective' therapist (this person understands my issues and is there to help me)</p> <p>'The self-help resources give me a sense of purpose'</p>	Improved engagement with depression management and increased self- management especially in relation to medication management leading to improved adherence

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
				These skills will be useful in the future (skill mastery)	
Wolf 2014*	Unclear – based on the interaction between the primary care clinic staff and the patient	<p>Patients with Type 2 diabetes attending federally qualified health centres (urban, suburban and rural) designed to cater for underserved US communities</p> <p>Diabetes champion to deconstruct tasks and assign responsibilities to clinic staff</p> <p>Clinic staff trained in counselling – teach back – positive encouragement, problem solving and coaching of patients to develop action plans</p> <p>Semi-structured script to encourage standardised interactions with patients</p> <p>No financial support received to sustain staff roles</p>	<p>Carve in - Diabetes guide reviewed between patients and PC staff. Colourful 48-page Diabetes Guide tailored to low literacy levels (5th grade level) with descriptive photographs to depict self-care concepts</p> <p>Patient engagement activities delivered by a nurse - Brief counselling intervention and action plans, iterative counselling process to identify individual behavioural goals that are easily attainable and increase their confidence</p> <p>Tracking system to follow up patients</p>	<p>Patient desire to have care provided within the PC practice as opposed to care from an outsourced service (even if more specialised)</p>	<p>Improved knowledge self-management for people with low health literacy</p> <p>Improved access/uptake of service</p> <p>Improved clinical biomarkers- HbA1C, PB, cholesterol</p> <p>Patient satisfaction</p>
	Unclear – based on the interaction between	<p>Practice re-design to incorporate brief diabetes education and counselling</p> <p>Referral to diabetes educator</p>	<p>Carve out - Diabetes guide reviewed between patients and diabetes educator</p> <p>Colourful 48-page diabetes</p>	<p>Authors propose that the outsourced intervention worked better for patients who had not reached</p>	

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		<p>Trained research staff delivered counselling</p> <p>At the time of the intervention there had been an injection of state funding that had resulted in more resources than had been previously available</p>	<p>guide tailored to low literacy levels (5th grade level) with descriptive photographs to depict self-care concepts.</p> <p>Patient engagement activities delivered by diabetes educator - Brief counselling intervention and action plans, iterative counselling process to identify individual behavioural goals that are easily attainable and increase their confidence.</p>	<p>glycemic control to reach it, those who were stable remained well managed (goal attainment)</p>	
eHealth plus telehealth					
Cherrington 2015	Unclear – based on the interaction between the patient and the peer CHW; the CHW and the Diabetes team as an advocate for the patient; the CHW is influenced by their interaction with the primary care team	<p>African American patients from underserved/safety net organisations in southern USA.</p> <p>Patients were part of a safety net neighbourhood/ CHWs were also peers from the same location and either had diabetes or cared for someone with diabetes</p> <p>Intervention free of cost but managed by peer support/community health workers</p> <p>Male and female 67.1 % of</p>	<p>Self management group education and support with goal setting; motivational interviewing and coaching</p> <p>Peers who also had life experience with diabetes and its management</p> <p>Community-based diabetes self-management education session</p>	<p>Shared experience, emotional supportiveness and availability; Family focused dynamic</p>	<p>Increased access to the primary care team via the CHW, better follow up.</p> <p>Improved knowledge/ understanding and adherence by patients around diet, physical activity, self monitoring of blood glucose, medication/insulin adjustment</p>

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		<p>participants and CHWs were female</p> <p>High levels of mobile phone ownership but low use of txt messaging or internet use</p>			
Chong 2012	Unclear – based on the interaction between the psychiatrist and patient	<p>Hispanic low income, uninsured patients with depression in a rural setting</p> <p>88% were women, married or with a partner. Low rates of education and employment. Poorer representation of men due to restriction from low level employment</p> <p>Patients oriented more to Mexican than to Anglo culture</p> <p>No previous treatment for mental health</p> <p>Telemedicine had been operating within the clinic for some time (organisational readiness) and for 5yrs the clinic had been trying to increase access to depression treatment for patients</p> <p>No costs incurred by patients. care provided in a clinic - patients taken to</p>	<p>Culturally compatible components – Hispanic speaking psychiatrists (one male, one female)</p> <p>Clinic housed in an agency located in the community – transport – easy to get there –</p> <p>Virtual meeting space</p>	<p>Patients said the program made them feel better and it helped me - feel supported</p>	<p>Increased access to depression management via culturally relevant service.</p> <p>Decrease in depression symptoms; improved medication adherence</p> <p>Patient satisfaction</p>

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		telemedicine room from the recruiter's office and not directly from the waiting room to reduce stigma			
Davis 2011	Unclear – based on the interaction between the clinic nurse/clinical pharmacist and patient	Veterans from minority groups in a rural setting with depression	Stepped care depression module with care escalated for those not responding to lower levels of care by involving more professionals with additional expertise	Unknown - authors propose these may relate to education and activation	Increased adherence to medication and better response to treatment
Fortney 2013*	Unclear – based on the interaction between the PCP and on-site nurse depression care manager and the patient	Medically underserved population in a remote setting (Arkansas' Mississippi Delta, Ozark Highlands) with depression and numerous comorbidities High unemployment/lack of insurance Half time funded depression care manager (nurse) – no prior MH training but received study training Decision support used to guide treatment – no clinical supervision Patients could choose 'watchful waiting' or antidepressant treatment	Practice-based collaborative care Upskilled staff at clinic education/activation, self-management goal setting,	Unknown – authors propose that patients were more likely to engage in self-management activities because the depression care manager (despite being off site) practiced a more intensive program and provided more encouragement to undertake physical, rewarding and social activities	Changes in depression severity, treatment response and remission Self-management Patient satisfaction

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		Patients preference for face to face or telephone encounters			
	Unclear – based on the interaction between multiple PC providers, off-site depression care manager and patient	Medically underserved population in a remote setting (Arkansas' Mississippi Delta, Ozark Highlands) with depression and numerous comorbidities High unemployment/lack of insurance Off-site team funded by study	Telemedicine based collaborative care Full time depression care manager CBT delivered by videoconferencing		
Shea 2009	Unclear – based on the interaction between the off-site nurse manager and the patient	Older ethnically diverse medically underserved patients with Type 2 Diabetes receiving Medicare ¾ spoke primarily Spanish Nurses trained in computer-based case management tools and to facilitate interactions through videoconferencing PCPs kept full responsibility of intervention patients –tried to avoid disruption of relationships	Web enabled computer and modem connection to existing telephone line – web cam and videoconferencing capacity Home glucometer, BP cuff connected to the telemedicine unit. Direct upload of data to clinical database Educational web page in English and Spanish and in regular or low literacy versions in each language	Unknown	Improved clinical biomarkers – HBA1c, BP and LDL cholesterol
Sheeran 2011	Unclear – based on the interaction between	Ethnically diverse sample of older patients with	Spanish and English versions of tele-monitoring tools and	I felt more connected to the agency	Change in behaviour Satisfaction

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Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
	the telehealth nurse and patient	depression – homebound Three Medicare certified home care agencies (urban, suburban and rural) Nurses trained on telehealth protocol	materials Touch screen and/or synthetic voice to prompt patients – on-line interactive screen can ‘ask’ patients questions Basic education and behavioural activation/goal setting	The frequent checks from the tele-monitor were comforting, reassuring I better understood my depression I was able to be more honest about my feelings with a machine I don’t like using a machine to discuss my feelings Telemonitoring reduces the sense of stigma	Reduction in depression severity
mHealth					
Wayne 2015	Unclear – based on the interaction between patients, HC’s, exercise groups and web-based program	Patients with type 2 Diabetes. The population was from a lower socioeconomic status neighborhood (90% of participants) and a midlevel-SES community (10% of participants). All patients under the age of 70yrs.	Health coaching protocol highlighting behaviour change for individuals with T2DM Concurrent exercise education program with trainers and blood glucose testing before and after exercise sessions	Meal photographing to enforce food portions and carbohydrate intake Reminder messages Self-awareness of habitual behaviours	Improved HbA1c, reduced weight and waist circumference. Satisfaction, Improved mental health outcomes and Quality of Life Increased knowledge and self

Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		<p>Patients included first nation, African, Caribbean, Caucasian, Hispanic, South Asian, South East Asian, West Indian. 36% unemployed</p> <p>Clients determined their own health related goals. 24/7 monitoring allowed intervention based on desirable progress, relapse and resistance. Interactive system</p>		<p>'Feedback was motivating', reduced feelings of isolation and being misunderstood</p> <p>Emotional happiness</p> <p>Therapeutic alliance</p> <p>Activation through co-monitoring</p>	management, control and confidence
mHealth and eHealth					
Davis 2015	Unclear – based on the interaction between patients, web-based programs, monitors and physicians	<p>Underserved, Low SES, English and Spanish speaking patients. Predominantly older, retired, unemployed and with disability</p> <p>Participants were all recruited in hospital as they were being discharged after experiencing acute exacerbations of illness.</p> <p>Patients were all uninsured in the US system of health care</p>	<p>Interactive educational component in which information was verbally transmitted to the patient with tips on symptom management via the RMD.</p> <p>Program and information folder, contact information, and preprinted education materials about symptom management provided free of charge</p>	<p>Upfront loading of information and attention by the PC at the home visits</p> <p>Personalised consistent feedback reinforced through habitual process of symptom reporting</p>	<p>Reduced hospital admission and Emergency Department use.</p> <p>Symptom management/self-management and confidence to manage their symptoms.</p> <p>Satisfaction and improved QoL</p>

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Study	Agency	Context	Resources	Mechanisms	Outcome (anticipated change related to self-management and self-efficacy)
		and hence part of medical insurance programs	Support and information from monitoring staff		

**Assesses two intervention arms*

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Table 9. Characteristics of included studies

Study Characteristic	Number	Study Characteristic	Number
Design		Setting	
RCT	9	General practice	6
Cluster RCT	2	Community health	2
Quality Improvement	1	Supported veteran program	1
Observational	2	Outpatient program	1
Descriptive evaluation	1	Community home care	6
Qualitative	1	Federally funded health centres/Medicaid	2
Cohort	2		
Intervention		Geographical area	
Telehealth	9	United States	15
eHealth and telehealth	7	Australia	2
mHealth	1	Canada	1
mHealth and eHealth	1		
Chronic condition		Vulnerability	
Depression	7	Older age (>55yrs)	3
Diabetes	6	Low SES	12
Multi-morbidity	5	Homeless/supported accommodation	1
		Rural/low SES/underserved communities	2

DISCUSSION

We identified eighteen studies testing a variety of electronic, mobile and eHealth interventions with vulnerable populations. The included studies provided limited insight into the relationships between context, mechanisms and self- management outcomes related to these interventions. . We identified a wide range of contextual factors and variation in the outcomes reported. Predominantly the interventions sought to persuade patients into believing they could self-manage their conditions by encouraging goal setting, providing rewards for achievement, enhancing the patient’s responsibility for symptom monitoring and providing education and additional support. Within this review patients were viewed by providers as relatively passive, and the level of patient response directly aligned to their intrinsic level of motivation. Health literacy, which can often be confounded with motivation, was only measured in one study and eHealth literacy was not assessed.

The provision of these tools to patients with chronic disease assumes that they directly impact on a patient’s level of health literacy, and subsequently their capacity to self-manage their health conditions. The studies in this review however reported poorly on self-management and literacy outcomes and we therefore don’t know if the intensive educational or behavioural activation components of the interventions identified were ultimately effective. Using tools to assess baseline health and eHealth literacy levels may therefore be beneficial particularly if the intervention is tailored to individual needs and abilities. It would be highly valuable if future research could unpack this further since the mechanisms around this were largely unclear from this review, and the inter-relationship between these factors is highly complex. This is particularly true for those patients with competing physical and/or psychological morbidities.

These findings have implications for future implementation. Other studies have reported variable uptake and poor maintenance, leading some to suggest that these interventions are only offered to

those with high levels of intrinsic motivation [36]. This review would suggest that more attention be given to identifying the specific needs of vulnerable groups and highly tailoring interventions to these to be more effective, since we found reasonable levels of satisfaction and acceptance when patients perceived the intervention to be relevant to their needs, and adequately supported. We found no evidence of negative patient consequences from any of the interventions. Acceptance of health technology may also be related to a participants' understanding of their condition and their overall interest in their own health or health literacy. There was also some evidence to suggest that the level of acceptance was not consistent for all participants who fall into the 'vulnerable' category. It is possible that this relates to the many and varied contextual factors providing influence at a given time, such as competing health, social and cultural issues, although this could not be elaborated from this review.

Although these tools have been widely studied in the general population, we generally found a lack of studies involving vulnerable participants, particularly in groups speaking English as a second language. Most studies were conducted in the US where social disadvantage was the major focus.

The strength of this review is a comprehensive search, the use of systematic processes to identify both quantitative and qualitative data and the use of Rameses publication standards as a basis for our reporting [19]. We also incorporated a realist matrix and mapped our results according to self-efficacy theory to both determine and understand the mechanisms by which eHealth and telehealth influences self-efficacy and self-management for vulnerable patients with chronic disease. This withstanding, we found the realist component of this review challenging. The major drawback for this approach in our experience was the limited descriptions of context and mechanisms provided generally within published studies. The limited quantity of usable data inhibited our ability to effectively identify why these types of interventions worked (or didn't work) differently across the varying primary health care contexts. Others have commented that the iterative and flexible

methods required for realist reviews are at odds with the inflexible, structured processes inherent when conducting systematic reviews generally [13]. Berg [46] in a review of published realist reviews found that limitations frequently cited include the scarcity of detail around the mechanisms by which an intervention was expected to work, and the diversity of contexts within studies which hamper generalisability. Developing the necessary skill set, and sourcing appropriate guidance to perform a realist synthesis was also a major challenge. We chose to use a realist matrix and narrative summary because it provided a more structured process that we could follow. Others have also highlighted difficulties with incorporating realist methods, arguing that few studies incorporate it successfully while maintaining transparent and systematic methods because ‘best practice’ is under developed [47] and there is currently little uniformity in practice [46].

CONCLUSIONS

Although electronic, mobile and telehealth interventions have been widely assessed in several disease specific groups covering the general population; specific research with vulnerable groups is much less comprehensive. Within the studies, the level of reported success was variable, but the reasons for this variation were not clear. Apart from intrinsic motivation, health literacy may be a factor influencing the reaction of vulnerable groups to technology. Symptom monitoring and management, goal setting, behavioural activation and motivational counselling were able to be successfully delivered by telephone or other modalities but efforts to engage patients by health care providers were lower than expected.

Social persuasion and goal setting were the dominant components by which studies sought to achieve better self-management. Other theoretical aspects that underpin self-efficacy such as vicarious learning and interaction with similar people were less used but may warrant further research.

We would also encourage in future research some assessment of both health and eHealth literacy if including vulnerable populations, and further work to differentiate specific requirements for these groups that might differ to the general population when implementing health technologies.

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AUTHORSHIP STATEMENT

SP contributed to the project methodology and design of the review; coordinated the review, designed and conducted the search, adjudicated and appraised studies, extracted and analysed data and drafted the manuscript. AP coordinated the deliberate forums and question development, designed and conducted the search, adjudicated and appraised studies, extracted and analysed data and reviewed the manuscript. LT and HS contributed to the search and the design of the analysis, extracted and analysed data and reviewed the draft manuscript. DM contributed to the question development through the LIP, and reviewed the manuscript. MH designed the IMPACT program of work, analysed and interpreted data and reviewed the manuscript. All authors have signed off on the final content of this manuscript

AUTHOR DISCLOSURE STATEMENT

The named authors declare that no competing or financial interests exist in relation to this work.

DATA SHARING STATEMENT

No additional data are available. Data extracted from included studies relevant to the discussion in this manuscript has been provided in Tables 4 to7.

FIGURE LEGEND

Figure 1. Logic Model

Figure 2. PRISMA Flow Chart

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REFERENCES

1. Gee PM, Greenwood DA, Paterniti DA, Ward D, Miller LMS: The eHealth Enhanced Chronic Care Model: A Theory Derivation Approach. *Journal of Medical Internet Research* 2015, 17(4):e86.

2. Voncken-Brewster V, Tange H, Moser A, Nagykaldi Z, de Vries H, T. vdW: Integrating a tailored e-health self-management application for chronic obstructive pulmonary disease patients into primary care: a pilot study. *BMC Family Practice* 2014, 415(4).

3. Gomez Quiñonez S, Walthouwer MJL, Schulz DN, de Vries H: mHealth or eHealth? Efficacy, Use, and Appreciation of a Web-Based Computer-Tailored Physical Activity Intervention for Dutch Adults: A Randomized Controlled Trial. . *Journal of Medical Internet Research* 2016, 18(11):e278.

4. Georgeff M: Digital technologies and chronic disease management. *Australian Family Physician* 2014, 43(12):842-846.

5. Royal Australian College of General Practitioners (RACGP): The RACGP Curriculum for Australian General Practice 2011. Melbourne: RACGP; 2011.

6. Mackert M, Champlin S, Holton A, Munoz I, Damasio M: eHealth and Health Literacy: A Research Methodology Review. *Journal of Computer-Mediated Communication* 2014, 19:516-528.

7. Kim H, Xie B: Health literacy in the eHealth era: A systematic review of the literature. *Patient Education and Counselling* 2016.

8. Ciere Y, Cartwright M, Newman SP: A systematic review of the mediating role of knowledge, self-efficacy and self-care behaviour in telehealth patients with heart failure. *Journal of Telemedicine and Telecare* 2012, 18(7):384-391.

9. Adams K, Corrigan JM: Priority Areas for National Action: Transforming Health Care Quality. Washington (DC): National Academies Press (US): Institute of Medicine (US) Committee on Identifying Priority Areas for Quality Improvement 2003.

10. Rollnick S, Miller WR, Butler CC: Motivational interviewing in health care: Helping patients change behavior. New York: The Guilford Press; 2008.

11. Maggie Bartlett, Ruth Basten, Robert K McKinley: Green shoots of recovery: a realist evaluation of a team to support change in general practice. *BMJ Open* 2016, 7: e014165.

12. Pawson R, Greenhalgh T, Harvey G, Walshe K: Realist review – a new method of systematic review designed for complex policy interventions. *Journal of Health Services Research & Policy* 2005, 10(Suppl 1):21-34.

13. Saul JE, Willis CD, Bitz J, Best A: A time-responsive tool for informing policy making: rapid realist review. *Implementation Science* 2013, 8(103).

14. National Public Health Partnership: Prevention chronic disease: A strategic framework, background paper. 2001.

15. Glossary of globalization, trade and health terms [<http://www.who.int/trade/glossary/en/>]
16. Telehealth [<http://health.gov.au/internet/main/publishing.nsf/Content/e-health-telehealth>]
17. Centre for Reviews and Dissemination: Systematic Reviews. CRD's guidance for undertaking reviews in health care. York, UK: CRD, University of York; 2009.
18. Jo Rycroft-Malone, Brendan McCormack, Alison M Hutchinson *et al*: Realist synthesis : illustrating the method for implementation research. *Implementation science* 2012, 7(33):1-22.
19. Wong G, Greenhalgh T, Westhorp G, Buckingham J, Pawson R: RAMESES publication standards: realist syntheses. *BMC Medicine* 2013, 11(1):1-14.
20. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group: Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 2009, 6(7):e1000097.
21. Glasgow RE, McKay HG, Piette JD, Reynolds KD: The RE-AIM framework for evaluating interventions: what can it tell us about approaches to chronic illness management? *Patient Education and Counseling* 2001, 44(2):119-127.
22. Tammy C Hoffmann, Paul P Glasziou, Isabelle Boutron *et al*: Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014, 7(348):g1687.
23. Neill J, Tabish H, Welch V, Petticrew M, Pottie K, Clarke M: Applying an equity lens to interventions: Using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. *Journal of Clinical Epidemiology* 2014, 67:56-64.
24. Kastner M, Estey E, Perrier L, Graham ID, Grimshaw J, Straus SE, Zwarenstein M, Bhattacharyya O: Understanding the relationship between the perceived characteristics of clinical practice guidelines and their uptake: protocol for a realist review. *Implementation Science* 2011, 6(1):1-9.
25. O'Campo P, Kirst M, Tsamis C, Chambers C, Ahmad F: Implementing successful intimate partner violence screening programs in health care settings: Evidence generated from a realist-informed systematic review. *Social Science & Medicine* 2011, 72(6):855-866.
26. Pawson R, Greenhalgh T, Harvey G, Walshe K: Realist synthesis: an introduction. ESRC Research Methods Programme Working Paper Series August 2004. University of Manchester; 2004.
27. Realist matrix [http://betterevaluation.org/evaluation-options/realist_matrix]
28. Fortney JC, Pyne JM, Moudén SB *et al*: Practice-based versus telemedicine-based collaborative care for depression in rural federally qualified health centers: a pragmatic randomized comparative effectiveness trial. *American Journal of Psychiatry* 2013, 170(4):414-425.
29. Wolf MS, Seligman H, Davis TC, Fleming DA, Curtis LM, Pandit AU, Parker RM, Schillinger D, Dewalt DA: Clinic-based versus outsourced implementation of a diabetes health literacy intervention. *Journal of General Internal Medicine* 2014, 29(1):59-67.

30. Shea S, Weinstock R, Teresi J *et al*: A randomized trial comparing telemedicine case management with usual care in older, ethnically diverse, medically underserved patients with diabetes mellitus: five year results of the IDEATel study. *Journal of American Information Association* 2009, 16:446-456.

31. Gabrielian S, Yuan A, Andersen RM, McGuire J, Rubenstein L, Sapir N, Gelberg L: Chronic disease management for recently homeless veterans: a clinical practice improvement program to apply home telehealth technology to a vulnerable population. *Medical Care* 2013, 51(3 Suppl 1):S44-51.

32. Gellis ZD, Kenaley BL, Have TT: Integrated telehealth care for chronic illness and depression in geriatric home care patients: The integrated telehealth education and activation of mood (I-TEAM) study. *Journal of the American Geriatrics Society* 2014, 62(5):889-895.

33. Chong J, Moreno F: Feasibility and acceptability of clinic-based telepsychiatry for low-income Hispanic primary care patients. *Telemedicine journal and e-health : the official journal of the American Telemedicine Association* 2012, 18(4):297-304.

34. Davis C, Bender M, Smith T, Broad J: Feasibility and Acute Care Utilization Outcomes of a Post-Acute Transitional Telemonitoring Program for Underserved Chronic Disease Patients. *Telemedicine journal and e-health : the official journal of the American Telemedicine Association* 2015, 21(9):705-713.

35. Eakin E, Reeves M, Lawler S, Graves N, Oldenburg B, Del Mar C, Wilke K, Winkler E, Barnett A: Telephone counseling for physical activity and diet in primary care patients. *American Journal of Preventive Medicine* 2009, 36(2):142-149.

36. Eakin E., Winkler E, Dunstan D, Healy G, Owen N, Marshall A, Graves N, Reeves M: Living well with diabetes: 24 month outcomes from a randomised trial of telephone delivered weight loss and physical activity intervention to improve glycemic control. *Diabetes Care* 2014, 37:2177-2185.

37. Bandura A: Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review* 1977, 84(2):191-215.

38. Bandura A: Self-efficacy: The exercise of control. New York: W.H. Freeman; 1997.

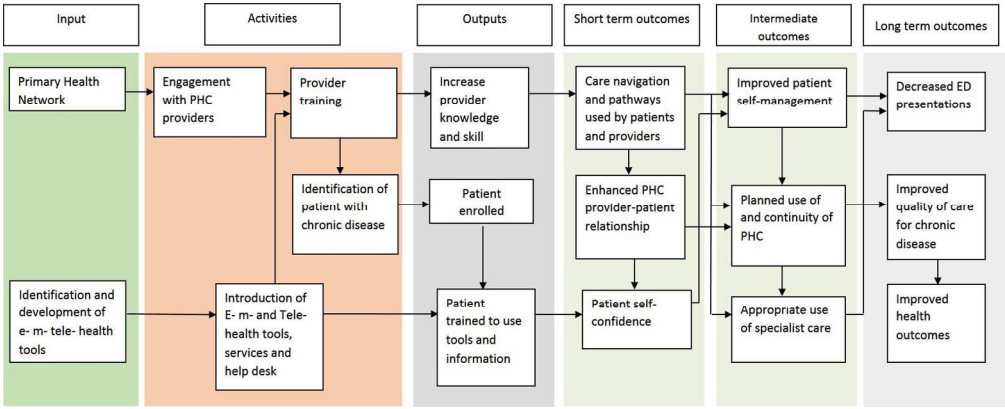
39. Lorig KR, Holman HR: Self-management education: History, definition, outcomes, and mechanisms. *Annals of Behavioral Medicine*, 26(1):1-7.

40. Hoffman A: Enhancing Self-Efficacy for Optimized Patient Outcomes through the Theory of Symptom Self-Management. *Cancer Nursing* 2013, 36 (1):E16–E26.

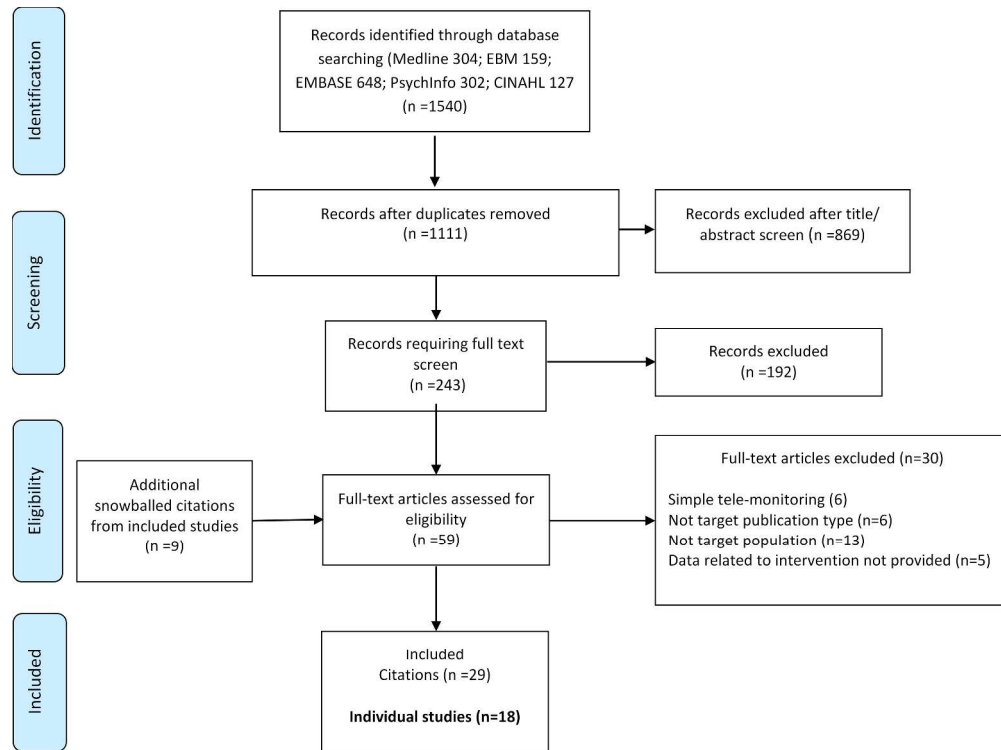
41. Cherrington AL, Agne AA, Lampkin Y, Birl A, Shelton TC, Guzman A, Willig JH: Diabetes Connect: Developing a Mobile Health Intervention to Link Diabetes Community Health Workers With Primary Care. *The Journal of ambulatory care management* 2015, 38(4):333-345.

42. Wayne N, Perez DF, Kaplan DM, Ritvo P: Health Coaching Reduces HbA1c in Type 2 Diabetic Patients From a Lower-Socioeconomic Status Community: A Randomized Controlled Trial. *Journal of medical Internet research* 2015, 17(10):e224.

- 1
2
3 43. Shea S, Weinstock R, Teresi J *et al*: A randomised trial comparing telemedicine case
4 management with usual care in older, ethnically diverse, medically underserved patients
5 with diabetes mellitus: five year results of the IDEATel study. *Journal of American*
6 *Information Association* 2009, 16:446-456.
7
8 44. Sheeran T, Rabinowitz T, Lotterman J, Reilly CF, Brown S, Donehower P, Ellsworth E, Amour
9 JL, Bruce ML: Feasibility and impact of telemonitor-based depression care management for
10 geriatric homecare patients. *Telemedicine journal and e-health : the official journal of the*
11 *American Telemedicine Association* 2011, 17(8):620-626.
12
13 45. Sheldon C, Waxmonsky JA, Meir R, Morris C, Finkelstein L, Sosa M, Brody D: Telephone
14 assessment, support, and counseling for depression in primary care medical clinics. *Cognitive*
15 *and Behavioral Practice* 2014, 21(3):282-295.
16
17 46. Berg R, Nanavati J: Realist Review: Current Practice and Future Prospects. *Journal of*
18 *Research Practice* 2016, 12(Article R1).
19
20 47. Walker D, Bergh G, Page E, Duvendack M: Adapting systematic reviews for social research in
21 international development: a case study on child protection *Shaping Policy for Development*.
22 The Overseas Development Institute (UK independent think tank on international
23 development and humanitarian issues); 2013.
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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE: Promoting self-management for vulnerable people with chronic conditions using electronic and telehealth tools: A systematic review and realist synthesis			
Title	1	Identify the report as a systematic review, meta-analysis, or both. Systematic review and realist synthesis	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3-4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5-6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Not registered Available from author
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Table 2
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. Quality assessment – rigour and relevance	8-9 and Table 3
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Realist matrix - 9



PRISMA 2009 Checklist

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	NA
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Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	10 and Figure 2
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Tables 4 and 5
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). Quality assessment – 'rigour and relevance'	Table 4 and 5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	NA
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	17
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19-20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	21



PRISMA 2009 Checklist

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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